POWER

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ELY C. HUTCHINSON, *Editor*

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1932

So this is Anno Domini nineteen hundred thirty-two!

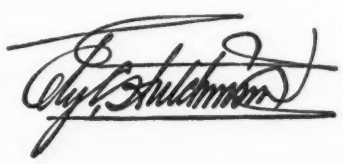
These first days of the new year are to all outward appearance no different from others of the year just closed. But somehow one cannot help feeling differently about them.

They have arrived after two intense years of international disturbance and decrescent business which have tried the courage of the peoples of the world and found it not wanting.

They find people feeling a new security come from the experiences through which they have successfully fought and a better understanding of the closer brotherhood and interdependence of nations. A growing ability to recognize and deal with world problems also brings us confidence in their early solution.

So it has come that there is today, a reading of the signs that bids us look forward to the new year with a stronger heart than has been justified since October of nineteen twenty nine. And in this we have the sound expectation that the new year will see life well back on the road to normal.

If then, we go about the business of the new year in the knowledge of what it may be made to yield to us, we shall be creating our own reward.



1931 — 1932

AT THIS TIME last year many signs pointed to an optimistic outlook in the power field for 1931. Some of these proved illusive because of the lag between general business and power activity, whereas others were tempered by the unexpected prolongation of the depression. Consequently, much of the new work indicated by preliminary plans and inquiries at the close of 1930 was held in abeyance during the year. This has resulted in much unemployment among engineers and in curtailed business for the equipment manufacturers.

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DESPITE THIS, the year was not devoid of reassuring prospects. The total central station load fell off only about four per cent and gross earnings were less than one per cent under those of 1930. This is in striking contrast to the barometer of general business, which, according to *Business Week*, now stands thirty-six per cent below normal. The reason for the excellent showing of the electric utilities is to be found in the increase in domestic load and the maintenance of commercial lighting demand, which combined to offset largely the loss in industrial load.

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THE UTILITIES put into service approximately 1,400,000 kilowatts of new capacity, of which 400,000 kilowatts replaced old equipment, that is, there was a net increase of a million kilowatts capacity, including both steam and hydro.

Construction among industrial power plants, while numbering a few new large installations, dealt more with a considerable number of replacements and small additions.

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A BRIGHT SPOT in the situation is the power work accompanying public works programs initiated to stimulate employment. This includes both new and modernization plans for state and municipal institutions, public buildings and municipal power plants.

Economically, power continues to hold its key position industrially, commercially and domestically. Its retrogression during the entire period since October of 1929 has been so small as to mark power business in the front line of those which have suffered least during the entire period of business decline.

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AS PREVIOUSLY STATED, the new business in power plant construction during 1931 failed to materialize to the extent that was expected. In the meantime, the day of the return to normal conditions inevitably approaches. The growth of domestic power load of something more than twenty-two per cent during the past year has created a demand upon existing utility power plants to such an extent that it is doubtful that there will be sufficient total capacity for power

generation, with existing equipment, within a short time after the power demands of industry commence to build back to where they were.

Certainly there is no doubt in the minds of people as to where the country shall be, financially and industrially, a few years hence. So it is rapidly becoming more apparent that in order to meet the power demand of the near future, new plant construction, remodeling and re-equipping of old plants, must shortly be got under way if the installations are to be completed in time to meet the normal increase of demand that is such a short distance ahead.

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THE NECESSITY for reducing power cost in industrial plants, and the limited extent to which this has been possible in some, is leading to new avenues of thought on the part of management, and obsolescence and amortization have taken on a new significance. So industrial power plant owners are viewing with better sympathy, and a better understanding, the viewpoints of their operating men concerning the advisability of plant reconstruction where such work shows a handsome return upon capital invested.

Industrial plant owners have been stimulated to no small degree in the consideration of their power problems by an increasing demand for lower costs in manufactured products and a belated recognition of the price of power as an essential factor in the total cost of the manufactured article. A large part of the consulting engineer's work has been in advising with industrial companies as to means for remodeling and otherwise improving operating economies of the older plants. Prospects are that more of this work will be done in 1932.

A number of people interviewed already have plans completely prepared and ready to put into immediate effect as soon as a feeling of reasonable stability of economic conditions is assured. Others not so timid, and determined to be ready for the return of business, are already proceeding with their rebuilding or new construction work.

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TO SUM UP the economic conditions, it may be said that new construction within the field of power generation is inevitable in 1932. It is apparent also that it will follow the most economic lines and that installations for the generation of power by steam, water, and oil engines will progress inexorably, and that the events which have acted to hold back construction during the past few years have necessarily brought to closer fruition the absolute necessity that provision shall be made to meet the power demands of the manufacturers, the industrial and business users, the municipalities, the utilities, and the domestic consumers.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Important Steam Plants Put Into Operation and Under

Two mercury-vapor plants to operate at higher pressure and temperature than the existing plant, two outdoor plants and additional high-temperature units are high spots of the year in steam power generation. Although boiler and turbine capacities have not increased, the largest pulverized-coal mill has gone into operation and the largest stoker is being installed

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Bremo is the first power plant to employ diphenyl oxide as a medium for air preheating

CENTRAL STATION developments during the year have been confined, with few exceptions, to completion of plants projected last year, and to the addition of generating equipment in old plants. Relatively few new plant projects have been announced during the year, but outstanding among them is the mercury power plant of the General Electric Company, now under construction at Schenectady, N. Y.

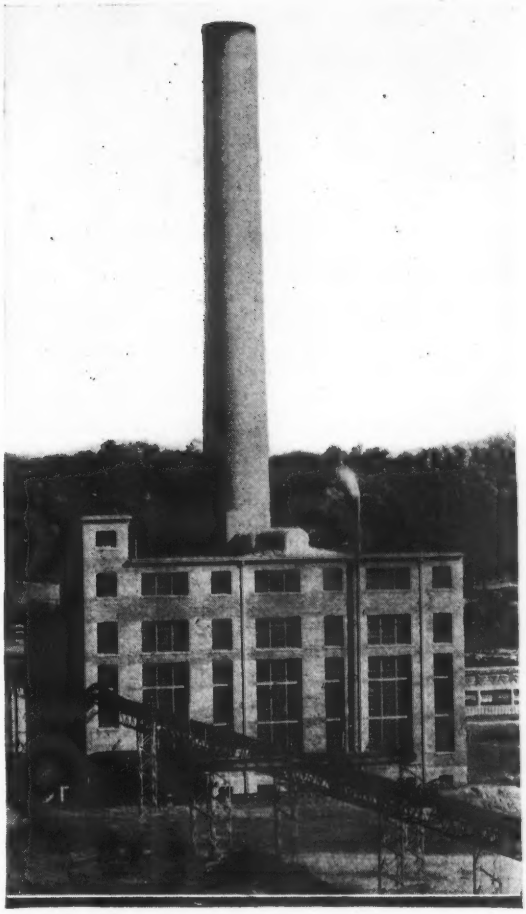
The installation of boilers of high steaming capacity continues, although there has been no increase in the capacity of single units over the records set by the Hell Gate and Kips Bay boilers. The largest-capacity high-pressure boiler put into operation during the year is at the River Rouge plant of the Ford Motor Company. It is designed to produce 700,000 lb. per hour. The same may be said of turbine capacities, the largest units under construction being two 160,000-kw. machines for the Brooklyn Edison Company.

If additions to old plants be excepted, more plants in the pressure range of 500 to 700 lb. were placed in operation or are under construction than in the 1,200 to 1,400 lb. pressure range. The higher temperatures now possible are probably responsible for this trend, since they permit pressures of about 650 lb. without the necessity of installing reheaters.

Greater interest in steam in the region of the critical pressure is evidenced by installations of three continuous-tube boilers, to operate at pressures of 5,000, 3,700 lb. and 2,500 lb. per square inch. These units are to be used for research work. One has been installed at Purdue University, one at the plant of Yarnall-Waring Company and the highest-pressure unit at the Bayonne Manufacturing plant of the Babcock & Wilcox Company.

The number of plants using gas for boiler fuel has increased noticeably. Many of these plants are using dump gas, which is attainable at attractive rates pending the building up of load on the large natural-gas pipe lines.

Construction



Tennessee Eastman Corp. power plant operates in parallel with central station service and supplies power and process steam

Although this applies more particularly to Southern and Western plants, it is nevertheless significant that gas will be used in the new addition to State Line.

An increase has been noted in the number of institutional and municipal plants. This trend is very likely traceable to the effort of municipal and state governments to provide useful employment.

A number of industrial plants placed in operation have made arrangements for the interchange of power between themselves and the local utility.

After a year of practically continuous operation the mercury unit at South Meadow was shut down in February for retubing the boiler, the immediate cause of which was a slight leak in one of the tubes caused by failure of a small mechanical detail. During the year's operation the unit generated 135 million kilowatt-hours at an average heat consumption of 10,100 B.t.u. per net kilowatt-hour. The recent experiences with mercury at Hartford have created greater interest in this type plant, with the result that two new installations are in progress.

The new General Electric plant will contain a 20,000-kw. mercury turbine and boiler, and, in addition, a steam boiler of 300,000 lb. per hour capacity. Doubling the capacity of this unit over the capacity of the mercury turbine at Hartford has been secured by increasing the mercury pressure to 125 lb. gage and by installing mercury heating surface on the upper portion of the furnace walls. The drums of the mercury boiler will be somewhat longer than those at Hartford. With a load of 20,000 kw. on the mercury turbine, 240,000 lb. of steam, at 475 lb. pressure and 465 deg. temperature, will be generated by condensing the mercury vapor, and the expected fuel rate is 8,800 B.t.u. per net kilowatt-hour. This steam, together with that generated by the steam boiler, is to be used for process, heating and testing steam in the General Electric works.

The mercury turbine will not be above the boilers, as at Hartford, but on the same elevation as the firing floor of the boilers. Mercury pumps will deliver the condensed mercury vapor to the boiler drums.

A second 20,000-kw. mercury-vapor unit has been ordered by the Public Service Electric Gas Company of New Jersey and will be installed as an addition to the Kearney generating plant. Steam from the mercury-vapor unit, at 350 lb. pressure, is to be used in a new 75,000-kw. single-cylinder turbine, also ordered for this plant. However, the major portion of the steam required by the new turbine will come from existing boilers at Kearney station.

Another feature of the General Electric Company's new plant is the outdoor construction of the turbine and boiler room. The picture, page 9, of a model of this plant shows the type of construction contemplated. During the year considerable attention was given to this method of decreasing first cost. Plans for the outdoor station of the San Joaquin Light & Power Corporation, at Herndon, Calif., have been approved, and construction is expected to start within the next few months. An initial capacity of 50,000 kw. is contemplated, and steam will be generated by natural gas or oil fuel at 1,450 lb. pressure.

Another Public Service Electric & Gas Company project, upon which construction was begun during the year, is at Burlington, N. J., where it is planned to install an 18,000-kw. turbine which will operate on 650-lb. steam pressure and 850 deg. at total temperature. This unit will exhaust at 200 lb. pressure to the turbines in the old portion of the station. A station in this pressure and temperature class that went into operation during the year is that of the Virginia Public Service Company at Bremo Bluff, Va. In this plant steam at 525 lb. pressure and 825 deg. is generated in single-pass straight-tube boilers and delivered to a 15,000-kw., 3,600-r.p.m. turbine. A feature of this installation is the use of diphenyl oxide in the air-preheating system. The heat-absorbing element is quite similar to an extended-surface economizer, in which a mixture consisting of 85 per cent diphenyl oxide and 15 per cent naphthylene is circulated. The diphenyl mixture is then piped to the heat-liberating elements, which are placed close to the mills and furnaces with which they are associated, thus eliminating a large amount of difficult duct work. Primary and secondary air is heated in separate preheaters, which permits of

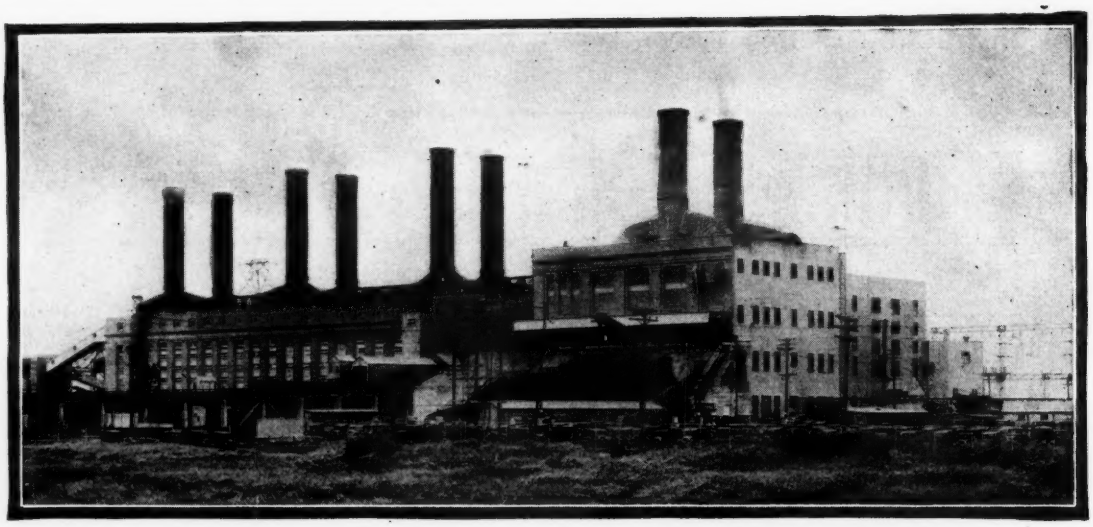
Steam Plants Placed in Operation or

Company	Name of Plant	Boiler			Steam Temp. Deg. F.	Economizer		Air Preheaters		Firing Method
		Number	Max Capacity, Lb. per Hr.	Pressure, Lb. per Sq.Ft.		Number	Surface, Sq.Ft.	Number	Surface, Sq.Ft.	
CENTRAL STATION PLANTS										
San Antonio Public Service	Conception Road	1	215,000	1,518	810	1	11,880	1	13,900	Gas
Pacific Gas & Electric Co.	Station A	3	500,000	1,400	750	2	17,900	2	46,654	Gas and oil
						1	21,111	1	42,413	
Milwaukee Electric Railway & Light Co.	Port Washington	1	690,000	1,390	840	..	.....	2	60,500	Bin P. C.
Chicago District Electric Gen. Corp.	State Line	3	500,000	1,200	825	..	.....	..	.....	Gas
Public Service Co. of Northern Ill.	Waukegan	2	495,000	732	760	2	28,600			
		1	300,000	732	760	1	6,860	2	64,088	Unit P. C.
Northern Indiana Public Service Co.	Michigan City	3	345,000	695	770	3	14,929	3	42,000	P. C.
Public Service Electric & Gas Co.	Burlington	1	29,800*	650	825	1	.....	1	.....	Bin P. C.
Louisiana Steam Products Inc.	Baton Rouge	1	350,000	640	700	1	9,801	1	2,700	Gas and oil
Wisconsin Power & Light Co.	Sheboygan	2	300,000	650	800	..	.....	..	.....	Unit P. C.
United Light & Power Co.	K St. Lincoln, Neb.	2	140,000	600	740	2	3,780	2	18,090	U. stoker
Super Power Co. of Ill.	Powerton	..	.....	600	...	..	.....	..	.....	.....
Virginia Public Service Co.	Bremo	2	200,000	525	825	..	.....	2	16,128	Unit P. C.
General Electric Co.	Schenectady, N. Y.	1	Mercury	125	958	..	.....	..	.....	.....
		1	300,000	465	...	..	.....	..	.....	.....
Northern States Power Co.	Riverside	3	250,000	450	750	3	12,096	..	.....	U. stoker
City of Lansing, Mich.	Municipal Plant	2	224,000	450	700	2	72,000	2	16,500	U. stoker
		2	259,000	....	...	2	84,000	2	19,320	.....
Indianapolis Power & Light Co.	Harding St.	8	190,000	440	725	8	5,760	8	17,800	U. stoker
City of Kansas, Kan.	Quindaro	1	180,000	420	730	1	1,843	1	19,500	Unit P. C.
Buffalo General Electric Co.	Charles R. Huntley	..	.....	435	750	..	.....	..	.....	.....
Northwestern Public Service Co.	Cody	2	72,000	400	750	..	.....	..	.....	Gas and oil
Brooklyn Edison Co.	Hudson Ave.	8	530,000	400	730	8	22,400	..	.....	U. stoker
Boston Elevated Railway	Lincoln	4	176,000	450	750	..	.....	..	.....	Unit P. C.
City of Tacoma, Wash.	Steam Plant No. 2, Tacoma	2	184,000	430	750	..	.....	2	34,000	Unit P. C.
Pasadena Municipal Light & Power Dept.	Pasadena, Calif.	2	210,000	460	750	..	.....	2	37,000	Oil
Kansas Power Co.	Dodge City, Kan.	2	720,000	400	750	..	.....	2	9,880	Gas and oil
Monterey Railway Light & Power Co.	Monterey, Mexico	..	.....	400	650	..	.....	..	.....	.....
West Virginia Hydro Electric Co.	Boncar	2	325,000	425	750	..	.....	..	.....	P. C.
Minnesota Power & Light Co.	Duluth	1	325,000	415	760	..	.....	..	.....	P. C. and gas
Potomac Electric Power Co.	Benning	4	13,700*	400	725	..	.....	4	19,970	U. stoker
Public Service Co. of Colorado	Valmont	1	275,000	375	650	..	.....	1	28,420	Bin P. C.
Public Service Electric & Gas Co.	Kearny	1	Mercury	125	958	..	.....	..	.....	.....
				350	750					
Texas Utilities	Tuco	2	81,500	290	650	..	.....	2	13,430	Gas
City of Eugene	Eugene, Ore.	1	105,000	250	656	..	.....	..	.....	Oil
Village of Wellsville	Wellsville, N. Y.	..	.....	175	477	..	.....	..	.....	.....
INDUSTRIAL POWER PLANTS										
Philip Carey Co.	Lockland, Ohio	2	.....	1,840	820	..	.....	..	.....	Unit P. C.
Ford Motor Co.	River Rouge	2	700,000	1,400	750	2	14,000	4	32,400	Bin P. C.
Anheuser Busch Inc.	St. Louis, Mo.	3	150,000	506	600	..	.....	3	.....	P. C.
Parafine Co., Inc.	Emeryville, Calif.	2	7,645*	450	656	..	.....	2	12,221	Oil
Procter & Gamble Mfg. Co.	Long Beach, Calif.	3	8,500*	450	606	..	.....	..	.....	Oil and gas
Tennessee Eastman Corp.	Kingsport, Tenn.	3	8,695*	450	575	..	.....	..	.....	U. stoker
Hershey Chocolate Co.	Hershey, Pa.	3	150,000	540	...	..	.....	..	.....	P. C.
Swift & Co.	Chicago, Ill.	5	100,000	300	...	..	.....	..	.....	Chain grate
City of Detroit, Mich.	Springwells Pumping	2	90,600	380	715	2	2,400	2	9,980	U. stoker
P. H. Glatfelter Co.	Spring Grove, Pa.	2	230,000	350	560	2	13,150	..	.....	Unit P. C.
Western Electric Co., Inc.	Kearny, N. J.	2	89,250	325	700	2	4,203	..	.....	Chain Grate
Pennsylvania State College	State College, Pa.	4	6,146*	250	525	..	.....	..	.....	U. stoker
M. J. Whittal Assoc.	Worcester, Mass.	3	50,000	215	488	3	1,093	..	.....	U. stoker
Great Northern Railway Co.	Whitefish, Mon.	3	28,875	250	...	..	.....	..	.....	Unit P. C.
Great Northern Railway Co.	Williston, N. D.	3	18,750	250	...	..	.....	..	.....	Chain grate
Great Northern Railway Co.	Great Falls, Kan.	3	36,750	250	...	..	.....	..	.....	Unit P. C.
Harvard Medical School	Boston	2	75,000	250	560	..	.....	2	6,126	Unit P. C.
Inland Steel Co.	Indian Harbor, Ind.	..	.....	270	615	..	.....	..	.....	.....
Illinois Steel Co.	South Chicago, Ill.	..	.....	250	680	..	.....	..	.....	.....
Ford Motor Co.	Dearborn, Mich.	3	10,000*	175	...	..	.....	..	.....	Oil and gas
University of California	Berkeley, Calif.	4	25,860	125	...	..	.....	..	.....	Gas
University of California	San Francisco, Calif.	3	7,290	150	...	..	.....	..	.....	Gas
Royal Victoria Hospital	Montreal, Can.	3	27,000	175	...	..	.....	..	.....	Chain grate
Lynchburg Foundry Co.	Radford Pipe Works, Va.	2	2,160*	175	...	..	.....	..	.....	Unit P. C.
University of Notre Dame	Notre Dame, Ind.	4	32,000	135	...	..	.....	..	.....	Chain grate

*Sq.ft. of heating surface.

Under Construction During 1931

Fans: Forced Number	Fans: Forced Capacity, c.f.m.	Fans: Induced Number	Fans: Induced Capacity, c.f.m.	Feed Pumps Number	Feed Pumps Capacity, g.p.m.	Main Units Number	Main Units Type	Main Units Capacity, Kw.	Main Units Blend Points	Condenser Surface, Sq.Ft.	Condenser Type	Circulating Pump Number	Circulating Pump Capacity, g.p.m.	Air Removal g.p.m.	Remarks
1	.....	1	.....	2	.....	1	Cross compound	7,600	3	.....	2 pass.	2	15,000	Ejector	Low-press. ele. older unit, 12,000 kw
2	165,000	2	290,000	3	1,200	2	Vert. compound	50,000	3	34,000	2 pass.	2	50,000	Steam jet	Steam and gas reheaters.
1	135,000	1	240,000									1	40,000		
2	112,500	2	185,000	..	.....	1	Tandem comp.	80,000	5	52,500	1 pass.	2	55,000	Twin 3 stg. jet	.....
..	.....	..	.....	..	.....	1	Tandem	125,000	..	.....	.....	..	.....	.....	.....
						1	Tandem	150,000							
6	72,900	3	243,320	5	800	1	Tandem comp.	115,000	5	80,000	1 pass.	2	132,000	3 stage twin jets	.....
3	96,200	3	177,000	..	.....	1	1 cyl.	68,000	4	50,000	1 pass.	2	42,500	Twin 3 stg. jet	.....
..	.....	..	.....	..	.....	1	3,600 r.p.m.	18,000	..	.....	.....	..	.....	.....	.....
1	118,000	2	111,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	.....	30,000	..	.....	.....	..	.....	.....	.....
2	56,000	2	80,000	2	500	2	3,600 r.p.m.	6,000	4	7,425	2 pass.	3	7,700	2 stg. jets	.....
				1	300										
						1	3 cyl. tandem	105,000	1	80,000	1 pass.	2	.....	.....	.....
..	.....	4	84,600	4	500	2	Tandem 36,000 r.p.m.	15,000	4	13,000	1 pass.	4	14,250	3 stg. jet	Diphenyl oxide air heating.
..	.....	..	.....	..	.....	1	Mercury	20,000	..	240,000 lb. st. per hr.	2 vert.	..	.....	.....	.....
3	97,000	6	85,750	2	1,000	1	Curtis	35,000	3	29,000	1 pass.	2	24,500	2 stg. jet	Steel shell condenser.
				1	500										
2	82,500	2	133,000	2	300	1	Reaction	20,000	4	21,500	2 pass.	2	11,500	Steam jet	.....
2	96,000	2	156,000	1	450										
8	66,600	8	110,720	4	400	2	Reaction	35,000	4	53,000	2 pass.	4	17,500	2 stg. jet	Double effect evaporators.
1	55,000	1	69,000	2	400	1	Reaction	10,000	1	15,000	2 pass.	..	.....	3 unit 2 stg. jet	Evaporators.
..	.....	..	.....	..	.....	2	1 cyl.	80,000	..	.....	.....	..	.....	.....	.....
2	.....	..	.....	2	80	1	Reaction	3,000	3	3,000	2 pass.	2	2,000	Steam jet	Evaporators.
7	200,000	16	155,000	6	1,500	2	Tandem comp.	160,000	2	101,000	1 pass.	..	.....	Steam jet	.....
..	.....	..	.....	..	.....	1	25 cycle	35,000	..	.....	.....	..	.....	.....	.....
2	58,000	2	87,000	2	750	1	1 cyl.	25,000	3	18,200	1 pass.	2	16,800	Twin 2 stg. jet	Evaporator.
2	56,500	2	63,000	1	1,000	1	Reaction	25,000	4	.....	1 pass.	1	6,000	2 stg. jets	Evaporators.
												1	13,000		
2	22,000	2	42,000	2	175	1	Impulse	7,500	3	7,500	.....	..	.....	Twin 2 stg. jet	Cir. water from semi artesian wells
..	.....	..	.....	..	.....	1	.....	10,000	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Single pass boilers.
..	.....	..	Nat. dr'ft	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Single pass. boiler.
8	25,000	4	75,000	2	1,000	1	Curtis	30 000	3	40,000	2 pass.	2	32,000	2 stg. jet	.....
1	102,500	1	216,500	1	2,000	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	Mercury	20,000	..	.....	.....	..	.....	.....	.....
						1		75,000							
2	22,150	2	37,000	..	.....	1	3,600 r.p.m.	7,500	1	14,000	2 pass.	2	7,000	2 stg. jet	.....
..	.....	..	.....	2	.....	1	Impulse	6,000	0	6,350	.....	1	12,000	Steam jet	.....
..	.....	..	.....	..	.....	1	.....	1,500	1	.....	.....	..	.....	.....	Turb. desig'd for future press. of 450 lb.
..	.....	..	.....	..	.....	2	Vert. eng.	6,060	..	.....	.....	..	.....	.....	.....
4	50,000	2	210,000	6	1,650	1	Vert. comp.	110,000	4	77,000	1 pass.	2	80,000	Steam jets	2-single effect evaporators.
3	.....	3	.....	3	400	2	Back press.	3,750	1	.....	.....	..	.....	.....	.....
2	31,400	2	38,500	2	240	1	Back press.	2,500	1	.....	.....	..	.....	.....	Triple effect evaporator.
..	.....	..	.....	2	300	1	Back press.	600	..	.....	.....	..	.....	.....	Exhaust press. 150 lb. D. C. generators
						1	Back press.	300							
3	30,000	..	.....	3	250	1	Back press.	1,500	..	.....	.....	..	.....	.....	Exhaust press. 90 lb.
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	5	50,000	3	1,500	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	45,000	2	75,000	3	300	2	Impulse	5,000	2	10,000	2 pass.	2	4,025	Steam jet	3-500 kw. aux. turbines.
1	53,000	1	90,000	2	400	1	Curtis	3,750	1	.....	.....	..	.....	.....	.....
1	42,000	1	75,000	1	600	1	.....	10,000	1	10,000	1 pass.	2	8,250	.....	.....
2	60,000	..	.....	2	350	1	Non-condensing	750	..	.....	.....	..	.....	.....	Power exchange with utility.
						1		1,250							
3	19,000	..	.....	..	.....	1	.....	300	..	.....	Jet	..	.....	.....	.....
						1		1,500	1	2,000	1 pass.	2	2,210	2 stg. jet	
..	.....	..	.....	2	100	1	.....	200	..	.....	.....	..	.....	.....	Locomotive terminal plant.
						1		300							
..	.....	..	.....	2	100	1	.....	200	..	.....	.....	..	.....	.....	Locomotive term'l plant, lignite fuel.
						1		300							
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Locomotive terminal plant.
..	.....	..	.....	..	.....	1	Back press.	1,000	..	.....	.....	..	.....	.....	Cottrell precipitator.
..	.....	..	.....	..	.....	1	.....	10,000	..	.....	.....	..	.....	.....	.....
						1		11,250							
..	.....	..	.....	..	.....	2	.....	10,000	..	.....	.....	..	.....	.....	.....
3	37,000	..	.....	3	400	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	4	.....	3	.....	..	.....	.....	..	.....	.....	..	.....	.....	Central heating plant.
		3	.....	2	.....	..	.....	.....	..	.....	.....	..	.....	.....	Central heating plant.
2	40,000	..	.....	2	120	1	Vert. comp. eng.	100	..	.....	.....	..	.....	.....	2-30 ton ammonia compressors.
..	.....	..	.....	2	7½x4½x10	1	Uniflow	600	..	.....	.....	..	.....	.....	.....
4	15,000	..	.....	2	200	..	.....	.....	..	.....	.....	..	.....	.....	.....

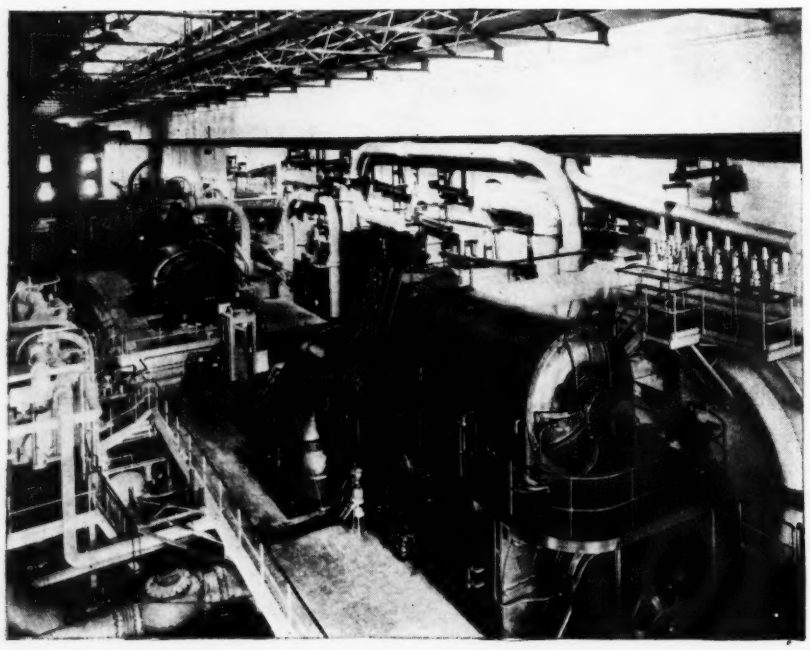


Two new 80,000-kw. units in Charles R. Huntley No. 2 of the Buffalo General Electric Co. are the largest single-cylinder turbines in operation

independent temperature regulation. As in the Perth Amboy plant, the station makes use of the direct-contact type of extraction heater. Four such heaters are used in connection with each turbine.

The Port Washington Plant of the Milwaukee Electric Railway & Light Company, now under construction, is both a high-temperature and high-pressure plant. Steam at 1,230 lb. pressure and 825 deg. will be used in an 80,000-kw. tandem-compound turbine. These steam conditions also apply to the new addition to the State Line station of the Chicago District Electric Generating Corporation, where a 150,000- and a 125,000-kw. unit are to be installed. Steam at 1,300 lb. and 850 deg. will be generated by gas-fired boilers. The 1,000-deg. experimental unit of the Detroit Edison Company at its Delray No. 3 plant has operated with steam at 900 deg. without any difficulties. New diaphragms were installed in the high-pressure cylinder of the turbine by the builders to replace the original diaphragms, which were not thought satisfactory for the high-temperature service. The latter were supplied with the turbine for preliminary running, rather than to hold up delivery of the machine.

The 1,400-lb.-pressure section of Station A contains two 50,000-kw. vertical-compound turbines



The number of high-temperature plants in operation or under construction may be interpreted to indicate a continued trend toward high temperatures for both moderate- and high-pressure plants.

During the year a number of high-pressure installations, mentioned in last year's review, have gone into operation. The rebuilt section of the Pacific Gas & Electric Company's Station A went into service early in February. In this station three new high-pressure boilers replace fifteen old boilers. They deliver steam at 1,400-lb. pressure and 750 deg. to two 50,000-kw. vertical-compound turbines. These units have operated at 62,000 kw. and have generated a kilowatt for under 12,000 B.t.u. Natural gas is the fuel, and at the present time about 27,000,000 cu.ft. is being used daily in the high-pressure boilers of the station. Steam reheaters have been provided for each turbine, and two of the three boilers are equipped with gas reheaters.

Two double-set 1,400-lb. boilers at the Ford Motor Company's plant went into operation about the middle of the year. These units each generate 700,000 lb. of steam per hour, delivered at 725 deg. to the 110,000-kw. vertical-compound turbine. The load on this unit at present has not been raised above 60,000 kw., the output being limited by the capacity of the present bus system.

To supply condenser cooling water for this new unit it was necessary to build a 12,000-ft.-long tunnel 40 ft. underground. The tunnel is 15 ft. in diameter. Vertical propeller-type booster pumps, each of 157,750 g.p.m. capacity, were installed in connection with this tunnel, which also supplies water for manufacturing purposes at the River Rouge plant.

At Station B of the San Antonio Public Service Company a 1,518 lb.-pressure boiler, supplying steam to a 7,600-kw. high-pressure turbine, has been placed in operation. The boiler is fired by ten combined natural-gas and mechanical-atomizing oil burners and has a capacity of 215,000 lb. of steam per hour.

The old plant was completely remodeled to take care of the new in-

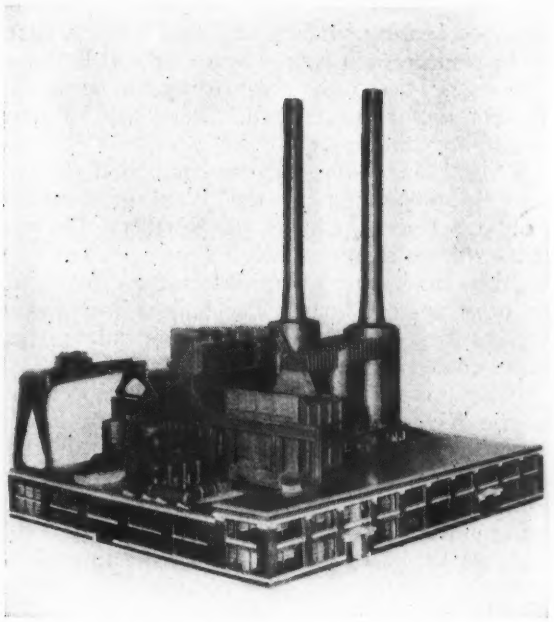
stallation, which operates in conjunction with the original equipment. The new high-pressure turbine exhausts at 175 lb., and is used to drive the older 12,000-kw. unit.

Operation of the new steam generating station of the Northern Indiana Public Service Company, on the shore of Lake Michigan, in Michigan City, Ind., was started early last year. This plant has a single-cylinder 68,000-kw. turbine, which drives a main generator rated at 64,000 kw., and a 4,000-kw. auxiliary generator on the same shaft. Steam at 650 lb. pressure and 750 deg. temperature is generated in three drum boilers, which are equipped with water walls and steaming economizers. Pulverized coal is fired horizontally, two unit mills per boiler being provided. The furnaces are of the slag type, the bottoms being air-cooled in one case and water-cooled in the other two furnaces. Tubular-type air preheaters provide preheated combustion air at 440 to 540 degrees.

The first unit of the new municipal plant at Kansas City, Kan., went into operation in October. While the present unit is of 10,000-kw. capacity, future machines of 30,000 kw. are planned. One boiler of 150,000 lb. per hour has been installed and generates steam at 400 lb. and 250 deg. superheat. A steam line connects the new plant with the old, and the 400-lb. steam is reduced to 175 lb. pressure and 100 deg. superheat for old plant use. The boiler is fired with pulverized coal, and ash is withdrawn as molten slag from water-cooled furnace bottom.

An unusual feature of the new plant is the circulation of the city water supply through the surface condenser and then to the settling basin.

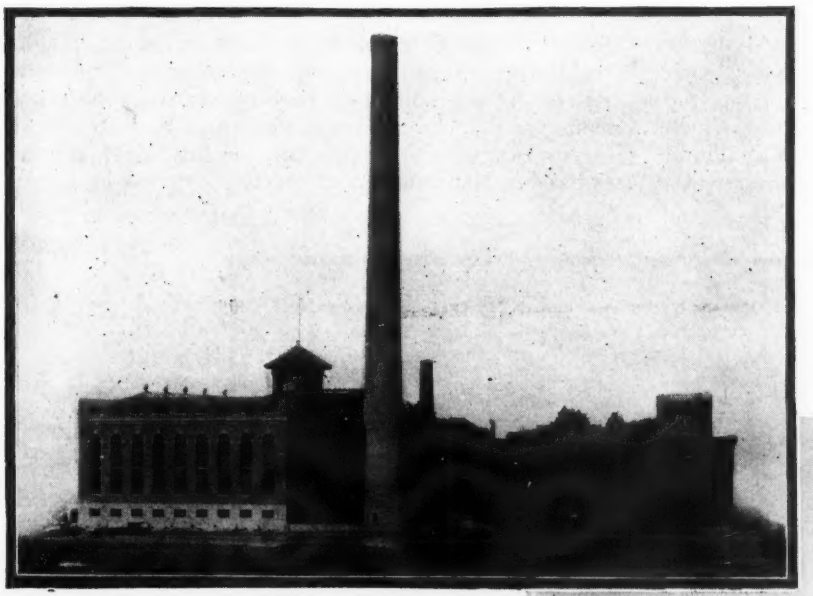
The initial installation of the new Harding Street plant of the Indianapolis Power & Light Company, which was placed in operation during November, consists of two 35,000-kw. turbines. Steam for these units is generated by eight cross-drum boilers at 440 lb. pressure at 725 deg. The boilers are fired by underfeed stokers which are supplied with air preheated to 310 deg. in mechanical air heaters.



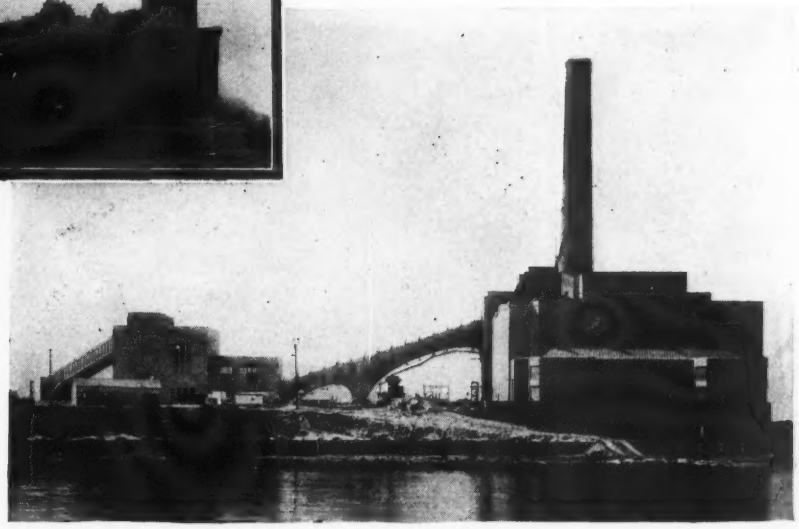
The 20,000-kw. mercury-vapor boilers and turbine of the General Electric Co. will be installed out of doors as shown by this model

The new K Street plant of the United Light & Power Company, Lincoln, Neb., contains two 6,000-kw. units from which steam is bled for district heating and process in a creamery.

Additions are being made to a number of the larger central stations. Outstanding among these are installations at Hudson Ave., State Line, Waukegan and Chas. R. Huntley. Because of the size of the units installed, the additions to the Hudson Avenue station of the Brooklyn Edison Company are particularly outstanding. Here two tandem-compound single generator units of 160,000 kw. capacity each



Hot condenser circulating water is supplied to manufacturing processes by the new power plant of M. J. Whittal Associates



The initial installation at the Michigan City plant contains one 68,000-kw. turbine and three 650-lb. pressure 750-deg. boilers

are being installed. Eight bent-tube boilers of 24,460 sq.ft. of heating surface each and water walls of 3,000 sq.ft. surface each supply steam at 400 lb. pressure and 730 deg. These units are fired by the largest underfeed stokers so far constructed. They are 15 retorts wide and 69 tuyères long.

Two 115,000-kw. tandem-compound turbines have gone into operation at the Waukegan station of the Public Service Company of Northern Illinois. These units receive steam at 625 lb. pressure and 750 deg. F. from boilers having a maximum rated capacity of 495,000 lb. of steam per hour. The boilers are fired with pulverized fuel, and have economizer, air preheater and water-cooled furnace walls.

Additions of 35,000 and 20,000 kw. were also made to the Riverside plant of the Northern States Power Company and the Moores Park plant of the city of Lansing, respectively. A notable new municipal plant is that of the city of Tacoma, Wash., a 430-lb. station using pulverized coal and containing one 25,000-kw. unit.

A 30,000-kw. addition to the Benning plant of the Potomac Electric Company completes the station, which now has a capacity of 208,000 kw. A new plant with an initial capacity of between 35,000 and 50,000 kw. is being planned for Buzzard Point in southwest Washington by this company. Both of the 80,000-kw. units in the addition to the Charles R. Huntley station of the Buffalo General Electric Company are now in operation.

The most outstanding industrial plant to go into operation during the year is that of the Philip Carey Company at Lockland, Ohio, where unusually severe steam conditions are employed. Two 6,060-hp. triple-expansion engines are designed to operate with steam at 1,840 lb. pressure and 820 deg. temperature. Each of the two boilers in the plant is rated at 150,000 lb. of steam per hour and is of special design, having 40-in. drums with walls 5 in. thick. Both economizer and tubular-type air heaters are provided, and four pulverizers serve each boiler through tangential burners. Exhaust from the engines at 60 lb. pressure goes to evaporators which supply steam for manufacturing processes. These evaporators are unusually large, each containing 5,000 sq.ft. of surface, capable of evaporating 60,000 lb. of water an hour.

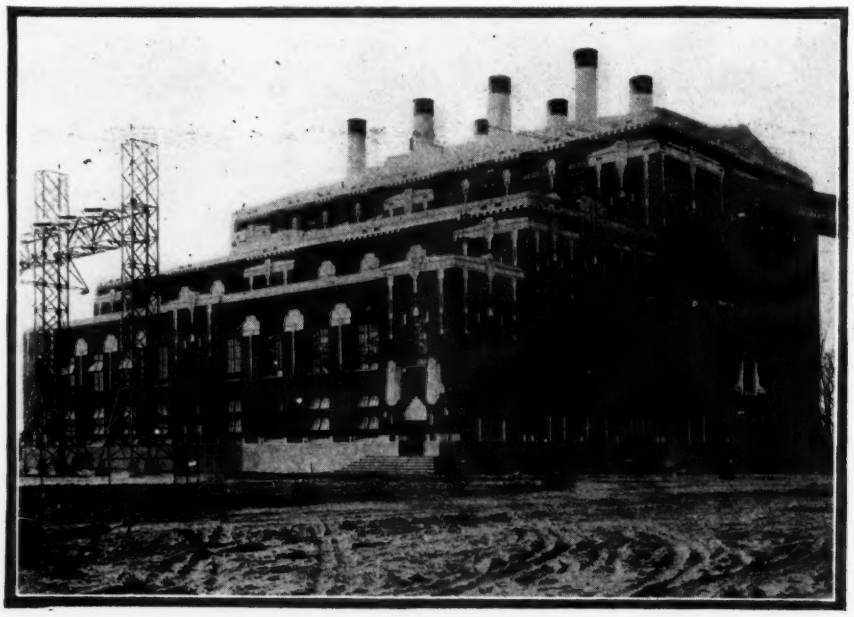
The Inland Steel Company, of Indiana Harbor, Ind., placed in operating a 10,000-kw. installation, and is putting in a second unit of 11,250 kw. capacity. Two other industrial installations of 10,000 kw. are reported, one at the Western Electric Company's Kearny plant and the other at the Illinois Steel Company's plant.

A new industrial power plant, unique because of its method of balancing power and steam requirements, is that of the Paraffine Companies, Inc., at Emeryville, Calif. At this plant two 7,645-sq.ft., 450-lb. boilers, fired with mechanical oil-gas burners, are installed. These supply steam to a 3,125-kva. generator unit and to process requirements through reducing valves. The turbine is arranged to exhaust to process at 40 lb. pressure, and to bleed steam at 150 lb. pressure to those processes requiring higher-pressure steam.

A triple-effect evaporator system has been installed and arranged so that it is possible to vary the demand for 40-lb.-pressure exhaust steam from the turbine by operating the evaporators either single- double- or triple-effect. The turbine operates in parallel with an outside source of power, so that at time of high process steam demand and low electrical demand power may be delivered to the outside source.

The new power plant of the Tennessee-Eastman Corporation, at Kingsport, Tenn., also operates in parallel with a utility system. The new power plant contains three 450-lb. boilers, which deliver steam at 575 deg. temperature to a new 1,500-kw. turbine. This unit exhausts against a pressure of 90 lb.

Another new plant on the Pacific Coast is that of the Procter & Gamble Company. Three 8,500-sq.ft. boilers, fired by natural gas and oil, are installed. They supply steam to the turbines at 400 lb. pressure and 150 deg. superheat. One 600-kw. turbine drives two 300-kw. direct-current generators, and the other turbine drives a single 300-kw. direct-current generator. Both units exhaust at 150 lb. pressure to pumps and to ejectors used in evaporative equipment. Eight-pound pressure steam from the pumps and ejectors is used in factory.



Harding Street station of the Indianapolis Power & Light Co. went into operation in November with an initial capacity of 70,000 kw. in two units

Consumption of the three basic fuels, coal, fuel oil and natural gas, has declined with the curtailed industrial activity of the past year, natural gas having been affected less than the others. Developments in equipment include a 69-tuyère stoker burning over 28 tons per hour, a pulverizer with a capacity of 50 tons per hour and advances in equipment design and in operating efficiency

Curtailments in Operating Expenditure Increase Efficiency of Fuels Utilization

BITUMINOUS COAL production has continued to decline. During the first eleven months of 1931 it was 346,400,000 tons as against 420,000,000 tons for the same period of 1930, and 484,000,000 tons in 1929. The generally depressed condition of industrial activity has played its part in this tonnage reduction. Other factors, however, have been equally important. The major influence has been the improvement in utilization efficiency. This has been particularly noticeable since 1925. Competition with fuel oil and natural gas has likewise had its effect.

The extent of this competition, however, has been somewhat overestimated. About 25 per cent of the bituminous coal mined is used as fuel in the transportation field (railroads and steamships), where natural gas is not competitive. Coke ovens use another 15 per cent, and neither gas nor fuel oil are competitive here. Thus the total productions of the three basic fuels are not in direct competition. The replacement of coal by natural gas has been estimated as not more than 6 per cent, while another 12 per cent is chargeable to fuel oil. This approximate loss of 18 per cent in tonnage is serious to the bituminous coal industry, especially in view of the excessive overexpansion of productive capacity and the resulting instability of market prices.

Improvement in operating methods within the coal industry, such as a greater mechanization and a wider use of improved cleaning methods, has resulted generally in the shipment of a better and more uniform coal to the consumer. The problem of stabilization of production, and its adjustment to consumption, by cooperation within the coal industry itself, appears particularly troublesome, and an increasing demand for state control as a solution of the coal industry's internal difficulties is markedly noticeable.

The natural-gas industry has felt the effect of the depression only slightly. Sales of natural gas declined about 10 per cent for the first six months of the year, due to decreased industrial use. The use of gas as fuel in public utility power stations, however, has increased over the year. The rapid expansion of gas distribution facilities, nationwide in extent, steadily continues. The 1,000-mi., 24-in. line from the Texas Panhandle to Chicago was completed and is now in operation. Other extensions are in the process of construction. The expenditure for pipe line construction for the year will probably run over $450,000,000. Among the projects now proposed is a 30-in. line from the Texas field to the New England States.

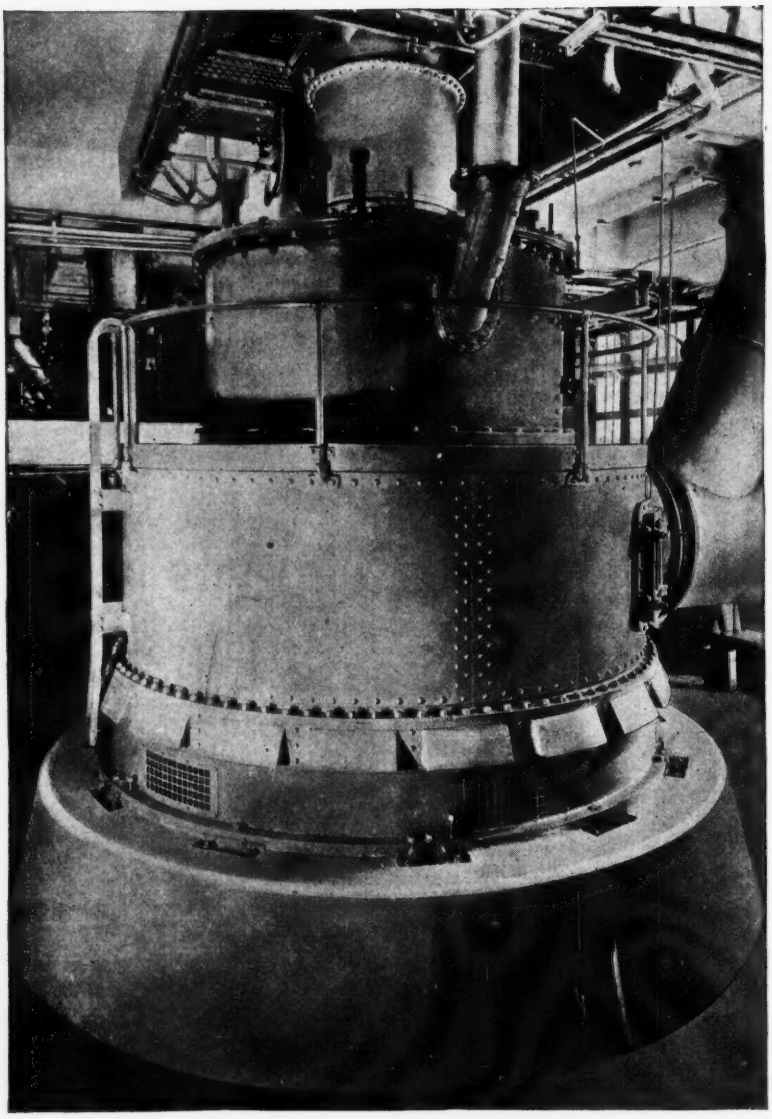
Many industrial power plants advantageously located in relation to the low-cost gas fields continue to effect operating economies by using natural gas either as the main or as the supplemental fuel. Among those noted are the plant of Morris & Company, at Oklahoma City, where natural gas, replacing pulverized petroleum coke, is stated as showing a reduction of 25 per cent in total power cost. The plant of the Murray Wood Products Company, of Memphis, is using gas to supplement the normal sawdust fuel to advantage. Among the utility stations where natural gas has recently been made the main fuel is the State Line plant, where advantageous rates on excess gas make this fuel economical.

The year's principal developments in coal-burning equipment have been made on the extremes of the capacity range. On the upper end, the title of "world's largest stoker" now rests with the latest installation at the Hudson Avenue station of the Brooklyn Edison Company where a group of 15 retort, 69-tuyère underfeed stokers are being erected. These stokers are 27 ft. long by 26 ft. wide, have a maximum capacity of 28.3 tons per hour each and are expected to be in operation shortly. The electro-hydraulic drive gives these stokers a range of coal feed of 100 to 1.

A new record in maximum pulverizer capacity has also been made by a large vertical ball-race mill recently installed at the Kips Bay station of the New York

Steam Corporation. This mill pulverized 50 tons of coal per hour, Development of mills of this capacity has been brought about by the necessity of keeping down the amount of building space devoted to pulverizing units is stations located in congested areas. Occupying a floor space of only 14 ft. 6 in. in diameter, a definite contribution toward conservation of space has been made while still maintaining the present low operating costs. The drive is a direct-connected 500-hp. vertical synchronous motor.

While the progress made has perhaps not been so noticeable, improvements have also been made in stokers for small industrial and heating boilers. A large number of these are now on the market, with some 57 manufacturers. The better-known makes are generally considered quite reliable and satisfactory. Stokers of this type have shown their ability to operate satisfactorily at ratings of 220 per cent, with heat releases varying from 32,000 to 43,000 B.t.u. per cubic foot of furnace volume per hour. These stokers also operate at average efficiencies varying from 68 to 71 per cent at normal rating. Development has taken the form of improved and more flexible electric drives, driving both the fan and stoker from the same motor, and mounting fan, motor and drive mechanism as an integral part of the stoker. An electro-hydraulic transmission for driving larger stokers has also been developed. This unit is very compact, the motor and transmission being mounted on one bedplate and being completely flexible, since speed can be varied from zero to maximum and also reversed as rapidly as the stoker mechanism will allow. The small domestic stoker has also made definite progress, both in number of installations and in reliability of operation.



Kips Bay mill pulverizes 50 tons of coal per hour and is driven by a vertical synchronous motor

A growing consciousness on the part of the bituminous coal industry that the public buys neither coal, oil, nor gas for its own sake, has been more noticeable. Realizing that the desire is for clean, safe, attention-free and automatic heat, and that the value of all fuels and mechanical devices on the market is governed by their ability to satisfy this desire, the industry is taking definitely progressive steps toward supplying this demand.

Sales of mechanical stokers for the first ten months of the year totaled 882, according to figures compiled by the Bureau of the Census. This is a considerable decline from the 1,055 stokers sold during the corresponding ten months of 1930.

During the ten months of 1931 eight pulverizers were sold for use with storage systems. These had an average capacity of 15.6 tons per hour. During the same time 65 unit mills were sold, with an average capacity of 3.3 tons per hour.

In spite of the relatively few new installations made during the year, improvement in design and in operating efficiency of fuel-burning equipment may be noted. The supports and understructure of one underfeed stoker have been completely redesigned, removing the middle support and taking the load off the crossbars. The entire load of this stoker is now carried on the front and rear, and other mechanical improvements have been made, thus clearing the space under the stoker for whatever changes in windbox construction may be possible. An outstanding improvement in the operating efficiency of underfeed stokers has been made by sectionalized zone-air control on the stokers of the Beacon Street plant of the Detroit Edison Company.

Each retort has two individual windboxes with adjustable damper-controlled entrance throats. In addition, four such windboxes are on the extension grates. Flexible wire controls for each windbox are brought out to a central board for manual control of air flow. Better air distribution has increased the CO_2 leaving the boiler by from $\frac{1}{2}$ to 2 per cent.

A similar installation has recently been applied to the larger stokers at Delray No. 3 station. Here each retort has four individual windboxes and control is completely automatic rather than manual. One general automatic control varies airflow to all the windboxes with rating

and in addition individual automatic controls regulate flow through each windbox to maintain equal distribution. Automatic control has the advantage of responding immediately to fuel bed changes.

Progress in the direct firing of pulverized lignite running as high as 35 per cent moisture with ball-tube mills is reported. Excellent results were obtained delivering the raw lignite directly to the mill and using preheated air or gas of over 500 deg. F. for drying within the mill. A definite tendency toward the use, in many instances, of highly preheated air, running as high as 600 deg. F. and over, becomes evident from examination of recent developments on both stokers and pulverizers.

A probable maximum coal-firing rate, with an individual burner, was obtained at the plant of the West Virginia Pulp & Paper Company, Piedmont, W. Va., where a cyclone-type pulverized-coal burner fired sufficient coal to produce 135,000 lb. of steam per hour. This is equivalent to over 200,000,000 B.t.u. per hour heat release with one burner. The same burner has also operated for hours with the boiler producing only 45,000 lb. of steam per hour, without difficulty in maintaining continued ignition.

The use of natural gas as a direct-expansion medium in single-stage turbines originally designed for steam is an interesting development that is gaining ground, especially around refineries, where cheap natural gas is amply available. Two 50-hp. units, normally operating on steam at 145 lb. pressure and 125 deg. F. superheat, and connected to centrifugal pumps, are in operation in a refinery in the Kettleman Hills district of California. Gas is supplied at 180 lb. pressure and 266 deg. F. temperature, and tests show that the performance is substantially the same as with steam.

Municipal wastes as a source of steam production still continue to interest engineers. The 60-ton garbage incinerator installed at Paterson, N. J., has been increased by the addition of an improved 200-ton incinerator. The refuse used as fuel is a mixture of about 65 per cent garbage and 35 per cent rubbish, and has a heat value of about 4,000 B.t.u. per pound. This plant is self-sufficient and generates all of its own auxiliary power from the steam which is generated with the refuse fuel. Such refuse disposal plants are also operating in the suburbs of Paris, and not only generate their own power, but supply the surplus for city water pumping.

In spite of the fact that the lowered prices on fuel oil have made pulverized coal for marine use less attractive, experimental development continues. Some thirty-odd vessels are now in service using pulverized coal. Successful operation seems to require a consistently high fineness of pulverization and coals with a minimum pyrites content. During the past ten years the percentage of marine horsepower generated by bituminous coal has fallen from 60.8 to 21.1 per cent. The coal industry has been seemingly indifferent to the possibilities of partly recovering this loss through development of more economical firing methods.

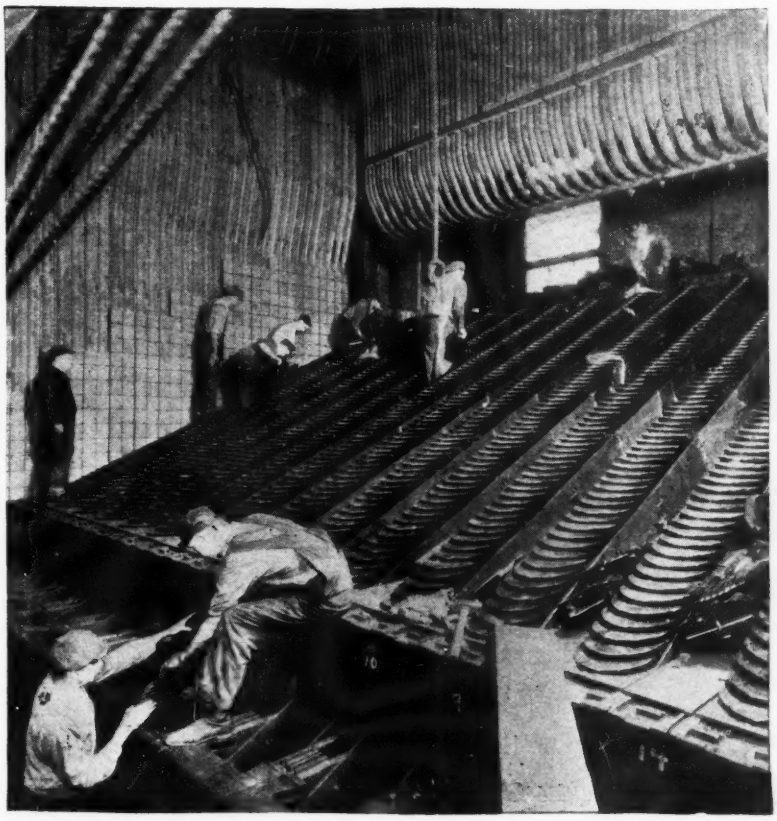
Indication of a revival in the use of stokers on shipboard is evidenced by two coke-cargo boats so equipped and also by the S. S. Beaverhill of the Canadian Pacific Railway, put into transatlantic service this year with stoker-fired boilers.

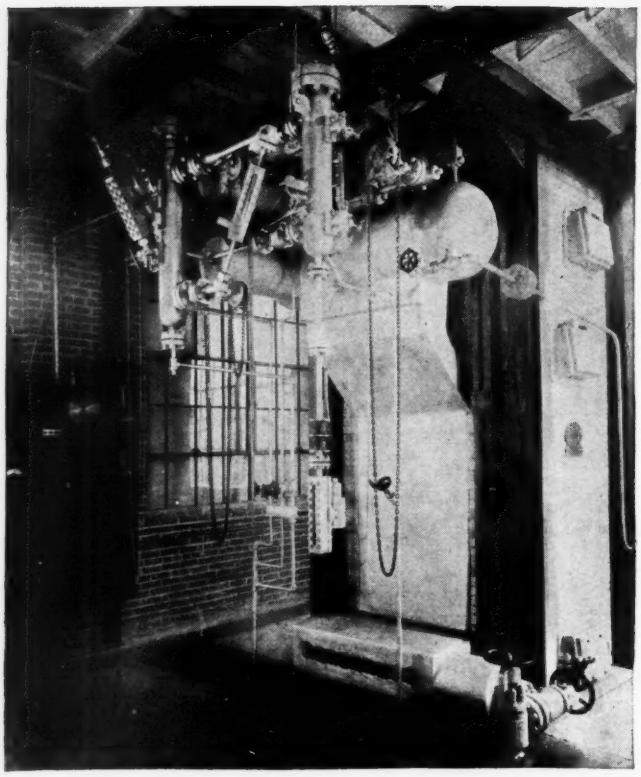
The general tightening up on expenditure, and consequent drive for economy in operation, has resulted in greater attention by many industrial plants to better and more scientific methods of coal purchase. It has been demonstrated that individual markets, and the relation of available fuels to plant equipment and operation, can be studied advantageously.

The drive for economy has likewise inspired research activity in fuel utilization. A noteworthy example has been the development of a method for determining the grinding characteristics of coal and the determination of the grindability index for a number of the more frequently used American coals. This is of help, not only to the pulverizer designer, but to the coal buyer as well, since a coal's relative ease of grindability is one of the factors requiring consideration in its purchase for a pulverized-coal plant.

A radical departure from the present "turbulent" design of pulverized-fuel furnace is suggested by experiments made at the Fuel Research Station, London, on a centrifugal furnace. Believing that turbulence in itself is not the end, experimenters have constructed a small experimental chamber designed to subject the coal particles to centrifugal force. The first experimental chamber was built to handle only 400 lb. of coal per hour. Heat releases amounting to over 500,000 B.t.u. per cubic foot per hour were maintained, while the brickwork remained in good condition. A new and larger chamber is now being constructed to carry the experiments forward on a larger scale.

New stokers at Hudson Avenue will efficiently burn 57,000 lb. of coal per hour over peaks





Boiler for 2,500 lb. pressure installed for laboratory research and steam testing purposes

New Trends in Boiler Practice Indicated in 1931

There was no increase in size of boilers in 1931. A number of single-pass boilers were installed both here and abroad. An 1,800-lb.-pressure unit went in operation. Critical-pressure boilers built.

STEADY PROGRESS along conservative lines rather than any sensational changes marked the 1931 program of boiler developments. The maximum size and capacity of boilers did not increase over that existing a year ago. Units with a capacity of more than a million pounds of steam an hour are still few and the rate of evaporation of 1,270,000 lb. of steam an hour made over a year ago is still the record for a single unit.

There is a noticeable trend among the plants going into operation, or laid down during the year, toward higher steam temperatures. The prevailing temperature of 750 deg., with few exceptions in this country, has been boosted in the new plants to 825 deg. A few plants abroad have been operated at this temperature for some years. The new St. Denis station now being erected at Paris is designed for 925 lb. and 930 deg. F. Experiments on the 1,000-deg. unit at Detroit have continued during the year, and it is now operating regularly at 900 degrees.

A trend toward the simplification of boilers is indicated by the increasing use of vertical single-pass units, some of which are operating on natural draft.

The largest boiler installation recorded during the year was that of eight boilers at the Hudson Avenue station of the Brooklyn Edison Company. Each boiler has a total heating surface of 24,450 sq.ft., with a completely water-cooled furnace, stoker-fired. Each boiler has a steam capacity of 530,000 lb. per hour, maximum, at 440 lb. and 750 deg. total temperature.

Two 1,400-lb.-pressure boilers of 700,000 lb. an hour capacity went into operation during the year at the River Rouge plant of the Ford Motor Company. These two boilers, which occupy the same space as two 250-lb.-pressure, 250,000-lb.-an-hour-capacity units, are the largest-capacity high-pressure units so far installed.

The first boiler installation in this country to operate at 1,800 lb. was put into operation during the year by the Philip Carey Company, Lockland, Ohio. Each of the two boilers installed is rated at 150,000 lb. of steam an hour with a total temperature of 820 deg. F. They have 40-in. forged drums having a thickness of 5 inches.

The installation of a single-pass boiler at the Duluth station of the Minnesota Power & Light Company is of interest inasmuch as there is only one boiler in the plant. The boiler is a sectional header unit 38 tubes wide by 40 high. It is designed for a capacity of 325,000 lb. of steam an hour on natural draft.

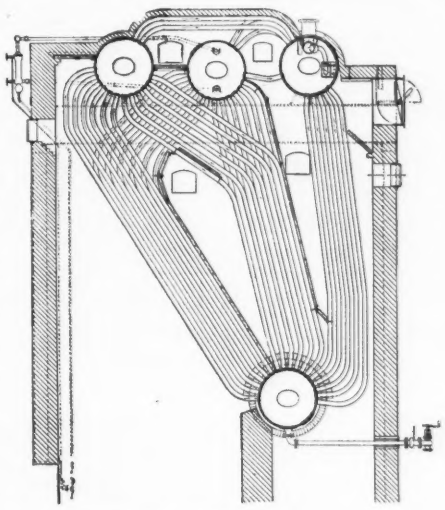
Two boilers of similar design were installed at the plant of the West Virginia Hydro Electric Company, Boncar, W. Va. These boilers are fired tangentially and operate on natural draft. In these units each furnace is unusually high with straight walls, and the boiler is directly above, with a superheater placed in a space between the fifth and sixth rows of boiler tubes.

Single-pass boilers are also used in the new Bremo station of the Virginia Public Service Company, which was put into operation during the year. The boilers are of the cross-drum type with a tapered gas pass. They are designed for 525 lb. pressure and 825 deg. total temperature and have a normal steam output of 160,000 lb. an hour. In this installation the steam temperature is held constant by means of surface-type desuperheaters under thermostatic control.

At the Gennevilliers station in Paris four single-pass

boilers of 300,000-lb. of steam an hour capacity are being installed to replace older boilers of much smaller capacity. Unlike the single-pass boilers used so far in this country, the Gennevilliers boilers have bent tubes with one header vertical and the other inclined at an angle of about 45 deg. The bottom five rows are plain-surface tubes, but above the fifth row extended-surface tubes are used. An extended-surface type superheater is between the bottom and center tube banks. The water-heating surface without fins is 11,680 sq.ft. and with the fins 31,600 sq.ft. They are stoker-fired.

One of the largest steam generators in Canada was placed in operation near the end of the year at the Municipal power station, Regina, Sask. This unit is a 16,500-sq.ft. bent-tube boiler with combination convection- and radiant-type superheater and tubular air heater. The unit will be fired by pulverized coal or natural gas, or both. The furnace, which has a total volume of 13,000 cu.ft., has two water-cooled walls, one steam-cooled wall and one refractory wall. The unit has a maximum capacity of 205,000 lb. of steam an hour at 400 lb. pressure with gas as fuel.



In this multiple circulation boiler the steam is liberated in two drums

Of particular interest in the marine field was the installation of a 3,200-lb.-pressure Benson-type boiler on the Hamburg American liner Ackermark. This boiler was installed in the same space as one of the older boilers and it has sufficient capacity to generate all the steam required to operate the vessel. The reduction in weight per unit of capacity was an important item. The 3,200-lb. unit weighs 61 tons less than the older boiler of about one quarter the capacity. Two Loeffler-type boilers now being built for the new station at Moscow will have a capacity of 350,000 lb. of steam an hour at a total temperature of 932 deg. F.

It is reported that one of the larger manufacturers is at present working on a self-contained boiler and turbine unit for marine service. The boiler will be built integral with the turbine, both being mounted directly on the top of the condenser.

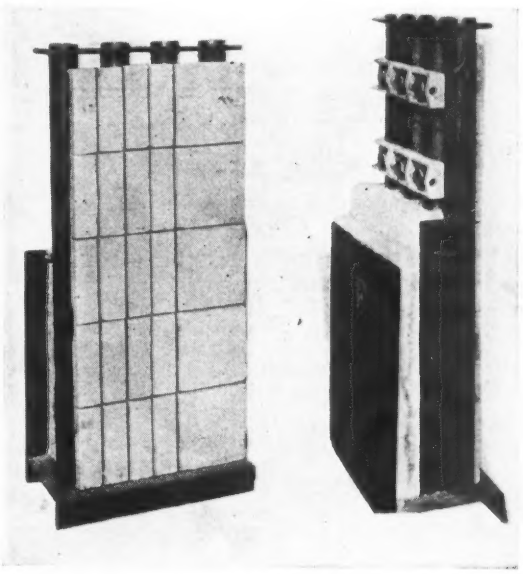
An innovation in bent-tube boilers to be announced during the year was a multiple-circulation unit in which every other section of tubes of the front bank is connected to the middle drum and every other section of tubes of the second bank is connected to the front drum. This tube arrangement divides the work of steam liberation from the front bank of tubes between the two drums. This tends to minimize the turbulence in the steam drum and give a more even water level and drier steam at high ratings.

A number of horizontal low-head bent-tube boilers were installed during the year. This type of unit is gaining in favor for the smaller industrial plants.

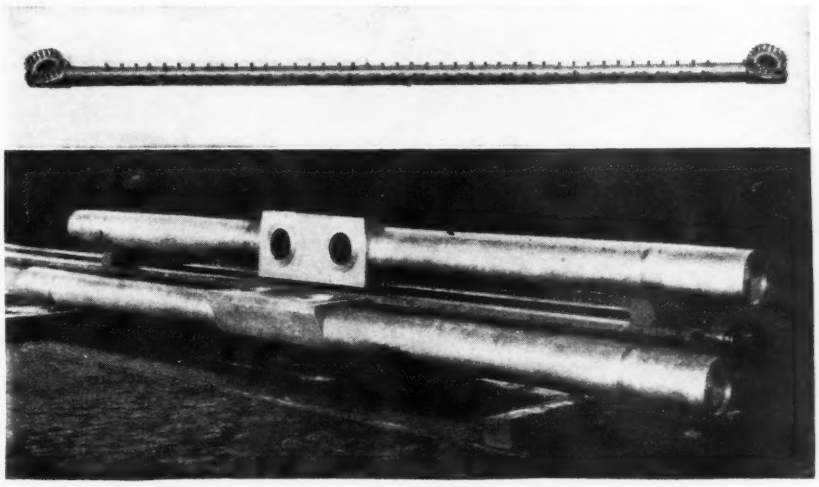
Two mercury-vapor boilers are now under construction; one will be installed at the Schenectady Works of the General Electric Company and the other at the Kearny station of the Public Service Electric & Gas Company, Newark, N. J. These units, which are practically identical in design, will develop 20,000 kw. from the mercury cycle (958 deg.) and about 330,000 lb. of steam (475 lb. pressure and 465 deg.) an hour from the mercury condensers and furnace water walls.

The upper portion of the furnace walls will be mercury-heating surface. These walls consist of a number of copper-filled three-tube elements which join into single-tube elements entering the drum. The installation at Schenectady will be of the semi-outdoor type and mercury feed pumps will be used. At Kearny the turbine and condensers will be above the boiler and the condensed mercury will return to the boiler by gravity. Both installations will be pulverized-coal-fired.

Experiments were carried on during the year on two high-pressure series steam generators. One of



Armoured type water wall employing toggle assembly



Top — Forged steel superheater header for Burlington station. Bottom—Forged steel superheater headers with center inlet

these boilers, a two-parallel circuit unit at Purdue University, has been operated at pressures up to 3,700 lb. and 830 deg. total temperature. The other boiler, a seven-parallel circuit unit erected at the Bayonne Works of the Babcock & Wilcox Company, was tested at pressures ranging from 1,550 to 5,000 lb. and a steam output per hour up to 4,600 lb. In these two units no drum is used. Each boiler consists of continuous seamless steel tubing supplied with feed water at one end and delivering steam from the other at any desired pressure.

A small high-pressure boiler to operate at 2,500 lb. was installed by the Yarnall-Waring Company for test purposes. This boiler forms a part of a complete research unit for the development of new ideas in connection with the manufacture of power plant devices and serves, essentially, as a laboratory in which to try out high-pressure apparatus. The evaporative surface of this boiler is in the form of an ascending multi-loop construction, the terminals of which are connected to two drums placed outside the gas pass.

Authorization of fusion-welded boiler drums by the A.S.M.E. code committee, in July of last year, gave impetus to the use of this construction. One company at the end of the year had shipped, or had on order, 150 fusion-welded boiler drums, besides a number of fusion-welded pressure vessels for other uses. As a result of tests carried out by the Navy Department, fusion-welded drums are to be used for the boilers of a number of the light cruisers now under construction.

The availability factor of boilers might now be said to compare favorably with that of steam turbines. The result of a recent study by C. F. Hirshfeld and D. U. Moran covering a period from July 1, 1928, to July 1, 1931, made on 244 boilers operating at pressures above 200 lb. and containing over 10,000 sq.ft. of heating surface gave the availability factor for stoker-fired class as 0.831; for pulverized-fuel-fired class, 0.869; that for oil and gas fired units, 0.864; and combined fuels, 0.927. As a result of the increasing reliability of steam-generating units, one-boiler one-unit plants are growing in favor.

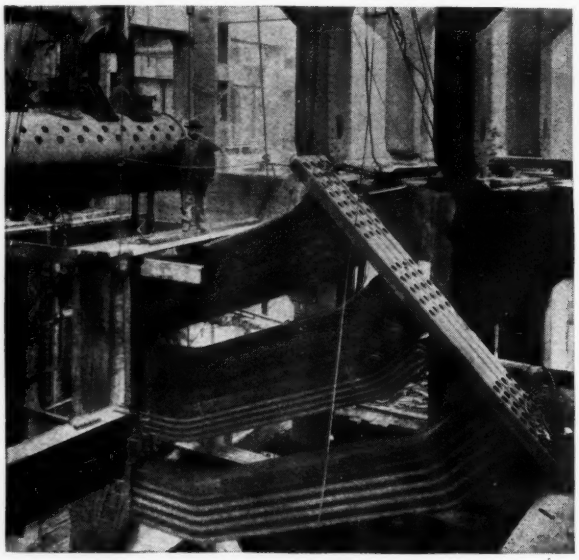
In developments in water walls one manufacturer reports a new armored-block type wall employing a toggle assembly which it is claimed permits the blocks to slide around the periphery of the tubes and maintain contact with the tubes regardless of change in alignment and spacing of tubes or expansion of the blocks. Also, any growth of the cast-iron in the blocks tends to bring the blocks into tighter contact with the tubes.

Another type of wall consists of tubes spaced in the usual manner in which each tube is provided with iron studs welded to the tubes and covered with refractory of suitable conductivity and thickness. The method employed, it is claimed, serves to maintain intimate contact between the refractory and the tubes and increase the heat conductivity from the wall surface to the tubes.

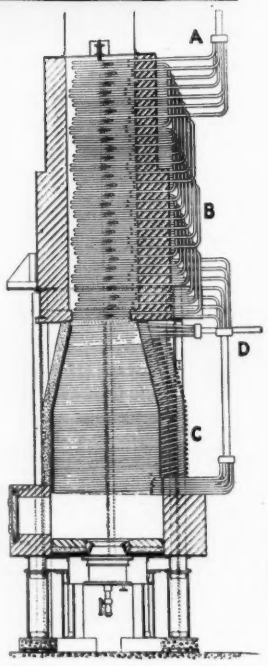
Interest in the slag-tap type of furnace continues. There are now upward of 70 installations in use comprising a total boiler capacity of more than 22,500,000 lb. of steam an hour. Operating experience would appear to indicate that this type of furnace is applicable to all coals having an ash fusing temperature below 2,500 deg. With coals having a higher ash-fusing temperature some type of flux may be necessary to increase the fluidity of the ash. Investigation made during the year on the fluxing of coal-ash slags by the Bureau of Mines disclosed that limestone, dolomite and iron ore or their equivalent in waste products are the most suitable. Limestone and dolomite are about equally effective from 2,600 deg. fusing temperature up.

A good deal of thought and investigation has been given in operating circles to the matter of water level and circulation in boiler units in both high and medium pressures.

An improved type of radiant-heat superheater was announced during the year. The design embodies bare tubes of special alloy set on rather wide centers and placed several inches away from the refractory wall behind them. In this position the tubes receive heat radiated from the fire on one side and heat reradiated from the refractory wall on the other.



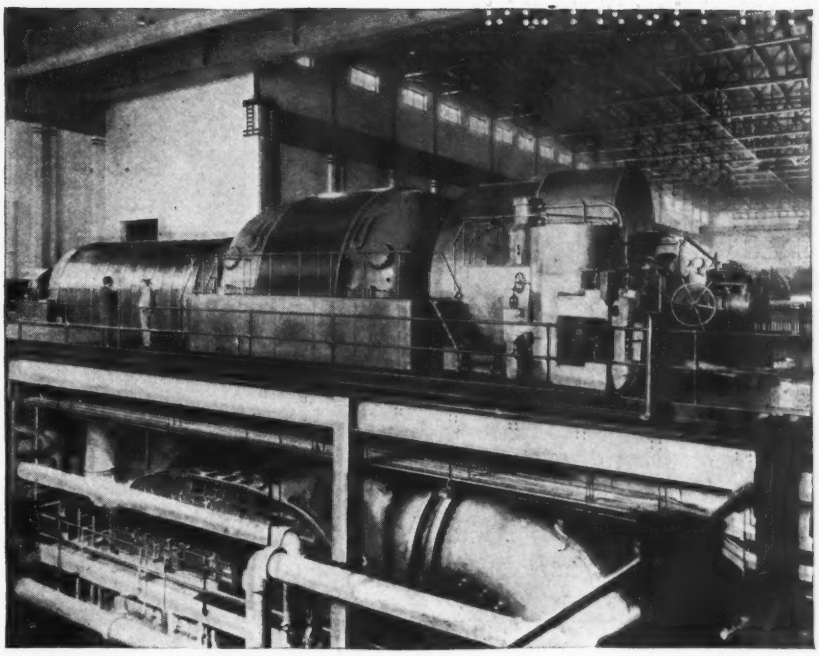
Single-pass boiler in course of erection at Gennevilliers power station Paris



Once-through series boiler
A—water inlet, B—economizer section, C—steaming section, D—steam outlet.

For the superheaters at the Burlington plant of the Public Service Electric & Gas Company, which will operate at 700 lb. pressure and 850 deg. temperature, a new type of header was developed. The headers are of the eccentric type, with integral forged elbows. They are made from solid forged steel billets, gun-bored eccentrically. This construction is said to permit making headers for boilers of large furnace width in one piece, the full width of the boiler.

A major improvement in high-pressure centrifugal boiler-feed pumps in 1931 was the adoption of forged steel in place of cast steel as a casing material. Improved pressure-breakdown devices of the labyrinth type were adopted to improve operation of the packed stuffing boxes.



Unit No. 5 at Waukegan has a capacity of 115,000 kw. and operates with steam at 732 lb. per square inch and 760 deg. F.

Progress in Steam Turbine Design

Continues toward higher steam temperatures, greater capacity high-speed unit and tandem compounding in large size machines. Two mercury turbines, double the capacity of the unit now in operation, have been ordered

DURING the past year there were placed in operation a number of prime movers of radical design. The 110,000-kw. vertical-compound unit which went into operation at the River Rouge plant of the Ford Motor Company is outstanding among these. It is the largest 1,400-lb.-pressure turbine in operation, and also the largest industrial unit. The two 6,060-hp. triple-expansion engines of the Philip Carey Company also were placed in operation. These units, supplied with 1,800-lb.-pressure and 820-deg.-steam at the boiler outlet, are now operating at the highest pressure of any prime mover in this country.

The 15,000-kw., 3,600-r.p.m. units reported last year as being the largest high-speed turbines to be built in this country were placed in operation at the Bremo Bluff plant of the Virginia Public Service Company. Their distinction as the largest high-speed turbines will, however, be short-lived, as during the year an 18,000-kw., 3,600-r.p.m. unit was ordered for the Burlington plant of the Public Service Electric & Gas Company. This unit will operate on steam of 650 lb. pressure and 825 deg. temperature, and will exhaust at 205 lb. pressure to the older section of that station.

No record-breaking capacity units were ordered during the year; nevertheless, the installation of high-capacity units still continues. Two 160,000-kw. units are being installed at the Hudson Avenue plant of the Brooklyn Edison Company. One of these, it is expected, will go into operation early this year. For the new 1,200-lb. addition to State Line there are on order a 125,000-kw. tandem-compound turbine and a 150,000-kw. tandem-compound unit.

The second 105,000-kw., 600-lb. triple-tandem-compound turbine went into operation at the Powerton station. Both of the 80,000-kw. units at the Charles R. Huntley station of the Buffalo General Electric Company went into operation. These are the largest single-shaft machines that have been built. At Station A of the Southern California Edison Company the two 50,000-kw. vertical-compound units, operating on 1,400 lb. and 750-deg. steam, were placed in operation. This makes four vertical-compound units now operating, one of which is the 25,000-kw. vertical-compound unit that went into operation last year at the South Amboy plant of the New Jersey Central Power & Light Company.

Except for regular overhauling, blade difficulties still cause the greatest amount of turbine outage. The Prime Mover Committee Report on Turbines, for 1931, shows that 8.72 per cent of the turbine outage was caused by blade difficulty, representing a decrease of 8.5 per cent below the previous year's report. A great amount of research is in progress at the plants of the various turbine manufacturers in an effort to obtain blades better able to withstand erosion and corrosion. Through the cooperation of two utility companies, experimental last-row blades have been installed in the turbine of each of these companies. This row of blading in each case is made up of as many materials as possible, so that a direct comparison may be made of their behavior under identical conditions. The blades are installed in groups of seven or eight of the same material. Not only are different materials used, but also different heat-treatment and nickel and chromium plate. One manufacturer reports that he is testing in service blades of 36 different materials.

During the year orders were placed for two new mercury turbines, each of 20,000 kw. capacity. One of these is to be installed in the new power plant of the General Electric Company at Schenectady, N. Y., and the other in an addition to the Kearney station. The physical dimensions of these two units will not be particularly larger than the 10,000-kw. unit at the South Meadow station, the increased capacity being secured

by an increase of pressure to 125 lb. per square inch and a temperature of 958 deg. It is understood that neither of these two units will have an overhung rotor such as was employed in the Hartford turbine.

The temperature of the steam supplied to the 10,000-kw. experimental high-temperature unit at Delray has been gradually increased in steps of 50 deg. up to 900 deg, without difficulties arising. The construction and operation of this unit has evidently given confidence to American engineers, as seven plants are under construction or in operation employing steam in the temperature range 800 to 850 deg. Those under construction are Port Washington, State Line and Burlington.

Design changes have been made by one manufacturer improving the turbine bearings with regard to lubricating features which allowed shortening them, thus permitting a reduction in length of the unit. This company has also developed new oil rings that promise to be more efficient than older types.

Use of welding in turbine and generator constructions continue. In the larger sizes it is used mostly for bedplate and stator construction.

In the high-capacity machines there is a trend to the use of separately driven fans and location of air coolers alongside of the generator instead of underneath.

Considerable attention has been given to methods of removing moisture from the last stages of the turbine. In the 160,000-kw. units for Hudson Avenue provision has been made for moisture removal from each stage in the double-flow low-pressure cylinder.

In addition to the Philip Carey engines, several others of unusual size are being installed. At the municipal plant of St. Bernard, Ohio, a 1,000-kw., four-cylinder vertical engine is being made ready for operation. This unit is said to be the largest four-cylinder vertical engine.

The Garfield Natural Gas Company is installing two large cross-compound engines driving gas compressors which deliver natural gas from Kentucky to Washington, D. C. These units each have one 25-in. high-pressure cylinder and one 52-in. low-pressure cylinder both with 42-in. stroke. They operate at variable speeds up to a maximum of 120 r.p.m. and have a normal output of 1,500 hp. The three 2,500-hp. engines reported last year as being installed at the Pilgram State Hospital at Brentwood, L. I., have gone into service.

The two 101,000-sq.ft. single-pass single-shell condensers for the 160,000-kw. units at Hudson Avenue remain the largest condensers, and will go into operation in the early part of this year. Both of these units, although made by different manufacturers, have the same surface and tube length. The water passage of one is split vertically, while the other is split horizontally.

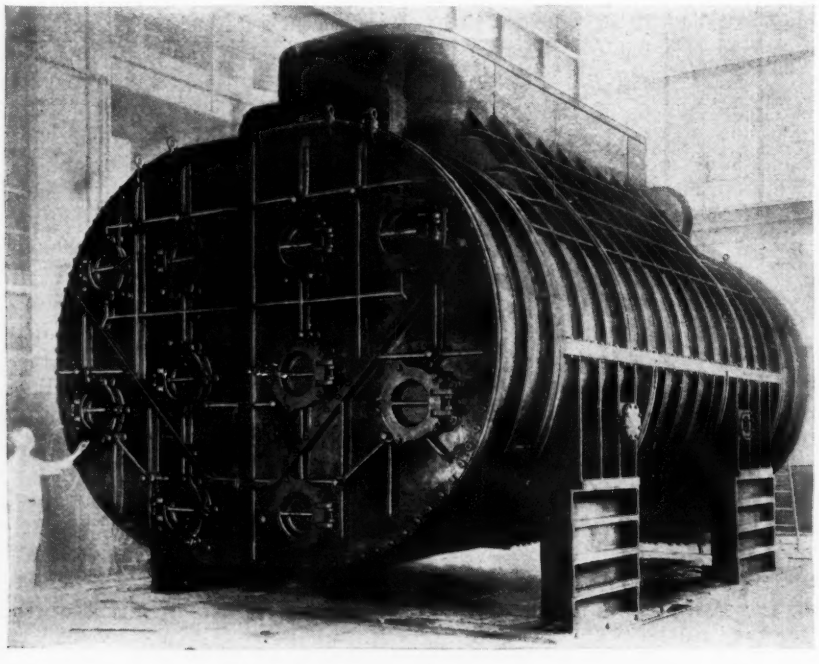
As two-speed pumps are provided to supply circulating water, the horizontal arrangement allows of an intermediate circulating water quantity by operating the pump serving the upper half at full speed and that serving the lower half at low speed. Another advantage claimed for the horizontal arrangement is the fact that the size of the condenser creates a syphon head very close to the maximum allowable. In case of an unusually low tide and warm water the syphon may be broken, in which case the lower half of the condenser having the horizontal division will continue in service.

Yorkshire brass containing copper, zinc and 2 per cent aluminum is being tried as a tube material in a number of plants where tube replacements have been high.

Welding of condenser shells continues to increase. This type of construction has been employed on condensers of 55,000 kw. capacity. For units of this size the condenser is shipped in sections that are bolted together on the job.

A condenser of unique design was installed at the Lincoln plant of the Boston Elevated Railway Company. It contains 34,000 sq.ft. of surface arranged with a wide steam lane extending down the center to the hotwell. Air offtakes on each side of the shell are shielded by closely spaced tubes which act as air-cooling and devaporizing sections. The main tubing is arranged in lanes radiating from these air offtakes.

A condenser of radical design built in England is arranged so that the steam flows down a central lane and reverses, flowing upward into the tube banks on the side of the central lane. It is claimed for this design that the condensate will be at the highest possible temperature, that heat-transfer coefficients are high and that the air is removed from the coldest part of the shell.



A central steam lane extending from top to bottom has been provided in this condenser serving a 35,000 kw. turbine in the Lincoln plant, Boston

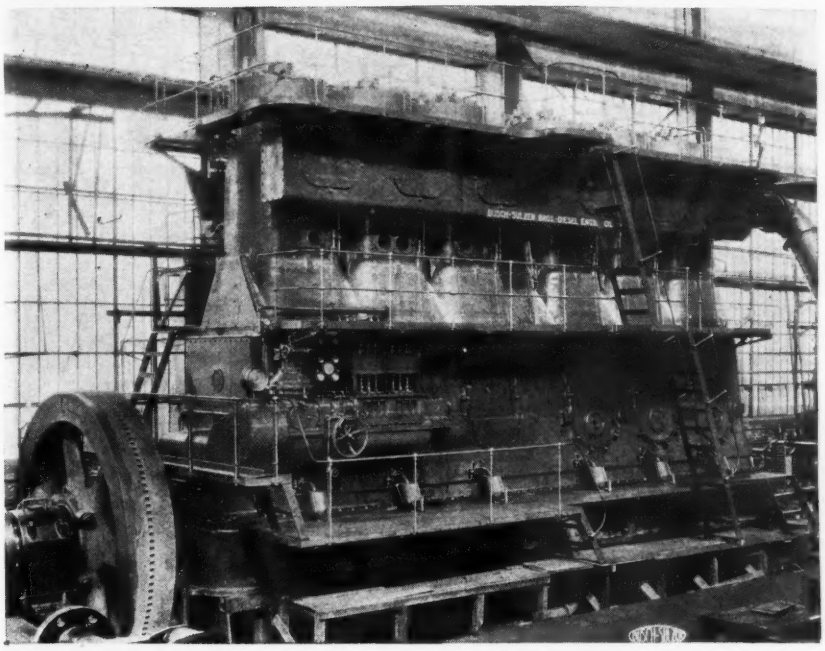


Fig. 1 — 14,000-hp. Busch Sulzer diesel for Tucson, Ariz., Gas & Electric Co.

In spite of the decrease in oil and gas engine orders in 1931 as compared to 1929 and 1930, these two industries have suffered less than have many other machine industries, and in the power field have slightly increased their relative position

Oil and Gas Engine Progress in 1931

THERE is every reason to believe that as soon as business in general shows an improvement, oil and gas engine sales will rise considerably over the 1929 maximum. Probably, however, it will be many years before the construction of large natural-gas engines will approach that of 1929 and 1930. The tremendous expansion of the natural-gas pipe lines created a demand for gas-engine compressors of unpredicated volume, and as pipe lines now serve most of the known fields and as the probable net income for natural gas marketing is better known, few additional lines will be constructed for some years to come, and single orders for 50,000 hp. will be notable by their absence, although the Bigelow Gas Corporation expects to place an order for 10,000 hp. in 1932.

Among the gas engine installations made during the year were the 1,200-hp. Worthington twin-tandem double-acting compressor units for the Continental pipe line from Oklahoma to Chicago, and the Chicago Pneumatic Tool Company's butane engines for the Phillips Petroleum Company's Oklahoma-to-St. Louis gasoline pipe line. Other large units installed during the year were a 6,600-kw. Allis-Chalmers blast-furnace-gas generating unit for the Illinois Steel Company and six Allis-Chalmers double-acting engines with twin-tandem cylinders 48 in. diameter and 60 in. stroke, direct-connected to two 82x60-in. air cylinders, to supply air to blast furnaces of the same steel company.

The manufacturer of smaller gas engines for oil field pumping has suffered severely, the reduced income of oil producers prompting these petroleum companies to rebuild old engines that had been abandoned in other oil fields. In some instances renewal parts have been made locally. Gradual decrease in available gas from the producing wells and the desirability of recompressing the gas for well-charging cause two-stroke-cycle oil engines to be preferred at many wells. As a consequence all of the makers of oil-field gas engines have evolved designs of oil engines of similar power and speeds.

While the application of oil engines has been far-flung, the major portion are still being installed in electric generating plants, oil pipe line stations, refrigeration plants, general industry and on motorships.

In Figs. 7 and 8 are shown curves illustrating the year-by-year purchase of engines, both as totals and as separated into four types. It will be observed that the solid-injection engines far surpass the air-injection units. The chief incentives toward the general adoption of solid injection has been the reduced manufacturing cost, made possible by the elimination of the air compression, and the better fuel consumption, due to the elimination of the lost compressor work.

Two marked trends in engine design became prominently noticeable in 1931, namely, higher speeds and greater unit output.

When the 15,000-hp. Blohm & Voss M.A.N. diesel was installed in the Hamburg Electricity Works in 1926 it was regarded as an example of the possibility of

constructing large diesels. Since then the installation of two 11,000-hp. M.A.N. 214-r.p.m. diesels in a Berlin substation has proved that engines of large unit capacity may be built economically. This has prompted the purchase of more large diesels, some being in the course of construction or installation at present, these include:

1—11,000-hp., Sulzer Brothers, 150-r.p.m., 8-cylinder, two-stroke-cycle, double-acting, air-injection unit for the La Margrange station in Switzerland.

1—23,000-hp. 8-cylinder, 840-mm. (33 in.) bore and 1,500 mm. (59 in.) stroke, solid-injection Burmeister & Wain diesel.

1—6,900-hp., M.A.N., two-stroke-cycle, double-acting engine for the Minden-Ravensberg, Germany, power plant.

2—5,400-hp., M.A.N., two-stroke-cycle, double-acting units for the Naples-Volturno, Italy, power plant.

3—7,200-hp., Sulzer Brothers, two-stroke-cycle, double-acting, solid-injection diesels for a Switzerland plant.

1—5,250-hp., two-stroke-cycle, single-acting, Sulzer Brothers, diesel for Shanghai, China, plant.

5—7,000-hp., Hooven-Owens-Rentschler, two-stroke-cycle, solid-injection, double-acting diesels for Vernon, Calif., municipal light plant.

1—3,000-hp., two-stroke-cycle, solid-injection, Busch-Sulzer Brothers, diesel for Freeport, N. Y., municipal plant.

1—4,000-hp. Busch-Sulzer Brothers, two-stroke-cycle, diesel for the Tucson, Ariz., Gas & Electric Company.

1—2,865-hp., McIntosh & Seymour diesel for Rockville Center, N. Y., municipal plant.

The five diesels for Vernon, Calif., are of especial interest since the plant, when installed, will be surpassed in capacity only by the Shanghai, China, diesel plant. The Vernon engines will be located in a region where natural gas, oil and hydro power are cheap. The operating costs of the plant, which will not go into service before the end of 1932, will be accorded interest, as the record should settle the question of comparative costs of generation in oil- and gas-fired steam plants and in a diesel plant of commensurate capacity.

In Europe the employment of large diesels as peak-load units or to supplement low-water in hydro-electric plants has come into general acceptance, but the industrial depression has prevented any further extension of this arrangement during 1931 although interest continues.

In this country diesels for hydro plants have not found general acceptance, due mainly to high first cost in past years. The present price trend should eliminate this obstacle, since a diesel station may now be built as cheaply as a steam plant, if not more so.

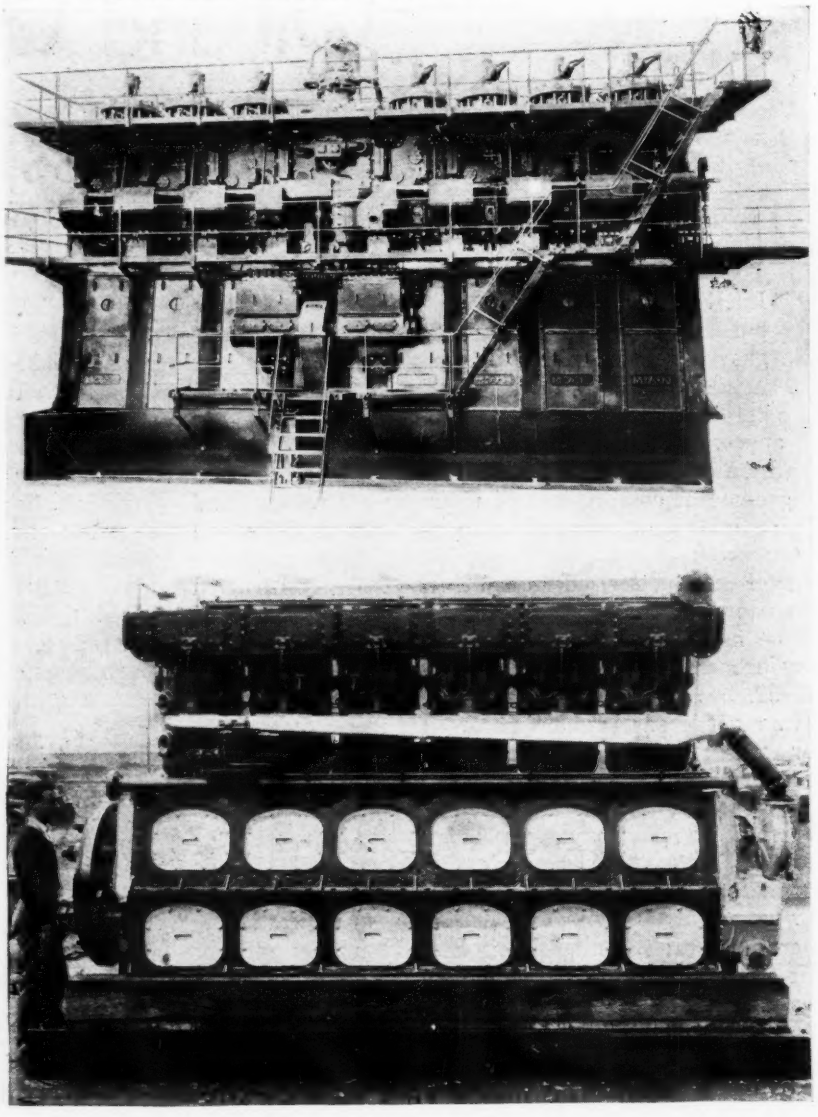
A second trend in design is higher speeds. Until recently engine speeds were held to exceedingly conservative values, 164 r.p.m. being standard for engines over 300 or 400 hp. This has been raised step by step, as better designs and improved materials permitted, until revolutions of 200 to 300 per minute are standard for engines of as much as 42-in. stroke; piston speeds of 1,200 to 1,400 ft. per minute are now accepted as reasonable in large units.

Along with this increase in revolutions has come an extension of the size field for trunk-piston engines. Where formerly all engines of over 1,000 hp. were expected to be provided with crossheads, recent designs provide for trunk pistons up to 300 hp. per cylinder. A notable example of this is the 10-cylinder, 3,000-hp. Busch-Sulzer Brothers solid-injection unit now being installed at the Freeport municipal plant. The trunk piston for large engines is not, however, universally accepted, since Rockville Center, N. Y., has just placed an order for a 2,865-hp. McIntosh & Seymour crosshead-type four-stroke-cycle unit. Nevertheless, the drift to higher speeds with trunk piston is evident; it reduces the engine weight and lowers the manufacturing costs.

Some engineers claim that the acceptance of higher speeds leads unquestionably to the more general adoption of the two-stroke-cycle principle, since bearing pressures do not reverse in the two-stroke-cycle engine and cast-iron pistons may be employed at speeds where light alloy pistons would be required on four-stroke-cycle engines.

For engines above 2,500 or 3,000 hp. the crosshead design is, of course, imperative, but definite choice between single-acting and double-acting designs has not

Figs. 2 and 3—11,000-hp. M.A.N. diesel of the type similar to those to be installed in Vernon, Calif., and an Ingersoll-Rand high-speed railroad diesel



been made. Sulzer Brothers, for example, construct single-acting engines up to 7,600 hp. and at the same time are building double-acting units of less power. In the capacities from 5,000 to 10,000 hp. one would be overly brave to declare that the double-acting principle would win universal acceptance. There is much evidence, however, that European builders are definitely committed to the two-stroke-cycle design for large powers, even Burmeister & Wain, long proponents of the four-stroke-cycle engine, now are equally enthusiastic in their advocacy of the two-stroke-cycle design for large outputs.

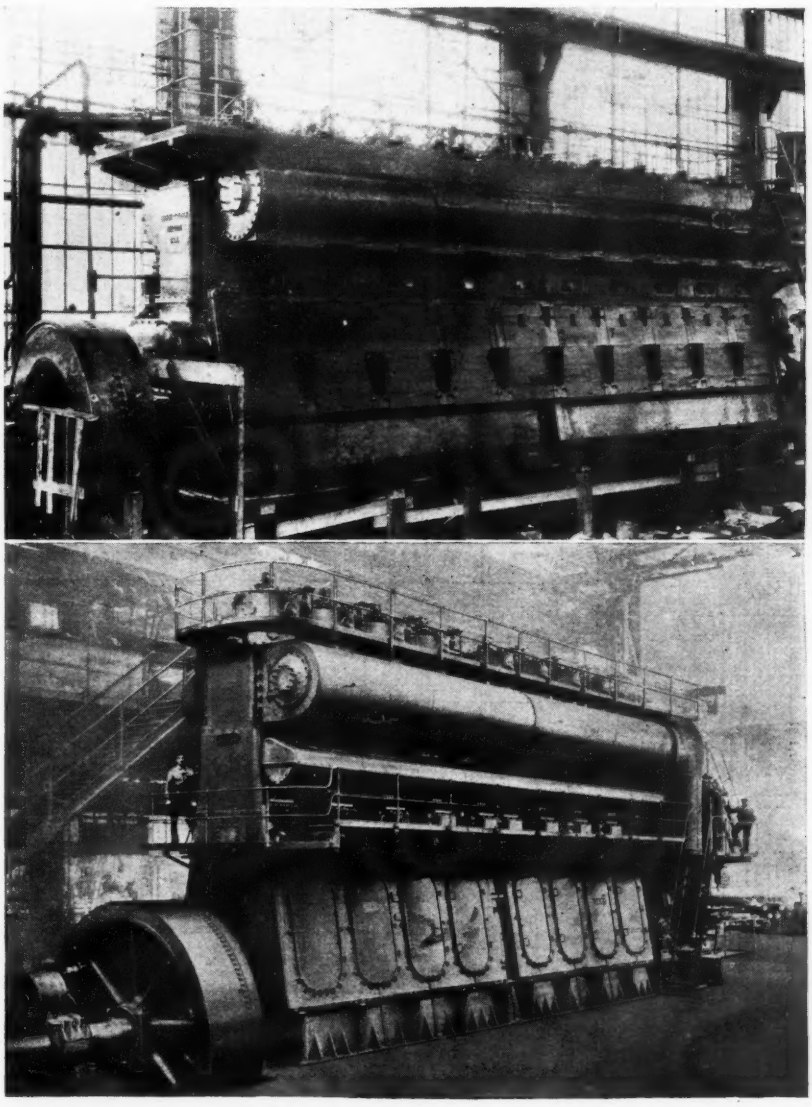
While several large diesels over 2,000 hp. were installed in this country before 1920, there has existed for a number of years a general feeling among power engineers that there was no economic inducement for the use of such lines in stationary plants. Many have pointed out that a need for peak-load units does not exist, since the newer steam plants carry base loads with ample capacity in the older, less efficient steam plants for peak load requirements. Of late there may be seen more than a mere trace of a feeling that the economic depression will lessen the number of new superpower plants being installed and that large diesel plants may prove to be the solution of peak-load capacity.

During the year a number of municipalities have either installed new diesel plants or increased the capacity of existing systems.

In the purely industrial factory field no increase in the rate of yearly horsepower installed was noted in 1931, due in the main to the general decrease in industrial activity. In this field the diesel meets the competition of purchased power. A study of power rates existing in various parts of the country reveals that in most localities an industrial factory with a load of over 1,000 kw. enjoys a marked advantage over plants requiring 250 to 500 kw. For this reason the most promising application of diesels is in factories requiring less than 500 kw., and manufacturers report the greatest number of inquiries as coming from these sources. On the other hand, the Commander Milling Company, Minneapolis, Minn., has just completed the installation of three 800-hp. Fairbanks Morse & Company diesels.

The marked reduction in price per horsepower which has taken place during the past two years has done much to sustain the demand for oil engines. There is reason to expect that even when business conditions improve the cost per unit capacity will be held at a low value by reason of a more general application of supercharging. Superchargers are more in evidence on European engines. American builders are still experimenting and have not found that the addition of this mechanism is commercially required at present. American purchasers of oil engines insist on considering a supercharged engine as an overloaded one and hesitate to employ the increased air supply save on short peak loads. But this attitude is likely to change in the near future, especially for large diesels.

Figs. 4 and 5—10-cylinder, 3,000-hp., trunk-piston diesel to be installed at Freeport, N. Y., 11,000-hp. Sulzer diesel



It cannot be said which system of supercharging will dominate. It is debatable whether precompression of the entire air supply or the compression of only a part of the air supply will gain the greater favor. The practice of including an exhaust-gas-driven turbine connected to a rotary compressor has not become common because of the high initial cost. Burmeister & Wain have evolved a positive displacement blower which is chain-driven from the engine shaft. This company claims that the arrangement eliminates the power loss brought about by the increased back pressure which exists if an exhaust-gas turbine blower is employed. A recent American patent covers the design of a displacement blower in which the blades are controllable to give a varied air capacity. This machine, to be described in a later number of *Power*, is reversible and can be geared or chain-driven to a reversing engine.

The total number of supercharged engines is not known, but of the exhaust-gas turbine blower design there are 65 engines on 37 motorships and 46 engines in 36 stationary

plants, totalling 208,975 horsepower in both these fields.

Oil cooling of pistons is being discarded by European builders of large units, due to the danger of explosion caused by overheating of the oil in the piston crown. On the other hand, builders of trunk-piston engines favor oil in preference to water, on the grounds that the latter may leak into the oil sump.

There has been a marked trend observable since 1929 toward the use of better metal for cylinder liners. At present many builders are employing a high-grade semi-steel with success. Alloys for light weight are being adapted for even larger engines. The general increase in piston speeds, with consequent rise in enertia forces, has forced a lightening of reciprocating parts. Aluminum piston heads and skirts, alloy rods and aluminum big-end bearings are no longer novelties.

Welding of the entire engine frame has been undertaken by M.A.N. in Germany and Davey Paxman in England. This is in many respects the outstanding progress of the year. Engine weights, as a result, have been reduced to 20 lb. per horsepower, and the M.A.N. engines built for German war vessels are down to 17 lb., as is the 600-hp. unit obtained by the United States Navy from the M.A.N. Switzerland works. This development has not been adopted by American builders, although several are experimenting.

Probably the development of greatest economic portent is the automatic diesel plant. Several have been installed in Germany and England, while in this country the notable example is the plant in the Chelsea Hotel, New York City, described in *Power*, June 23, 1931.

Locomotive application continues to be one of the most interesting for diesels. In this country seven diesel locomotives were sold in 1931, a decided decrease from the 1930 record. In Europe Sulzer Brothers are most active in this work and have orders for over 15,000 hp. of locomotives.

To the popular eye the automotive diesel ever remains in the foreground. In Europe many firms, including Benz, M.A.N., Saurer, Krupp and Lister have built enough engines of the truck and bus type to demonstrate their utility in service. In this country the urge for a cheap-fuel automotive engine has not been as pronounced, and it must be confessed that, so far, a commercial American automotive engine has not appeared. Many are experimenting; the Hill Diesel Engine Company and the Cummins Engine Company actually have engines in service. The latter firm entered a diesel automobile in the Indianapolis races during the year, which registered a speed of over 80 miles an hour.

With the railroads facing the loss of much short-haul business to trucks, there is reason to believe that soon more than one road will build up a fleet of large dieselized trucks.

Research work was carried on during the year by several oil-engine builders, particularly at Langley Field and Pennsylvania State College. Langley Field continued its study of combustion behavior and the influence of cylinder shape. At Penn. State spray-formations research was actively continued. Study of the entire problem of fuel specifications lagged to some extent and is now being taken up again. The setting up of a standard fuel specification is the greatest factor that will increase the application of diesel engines.

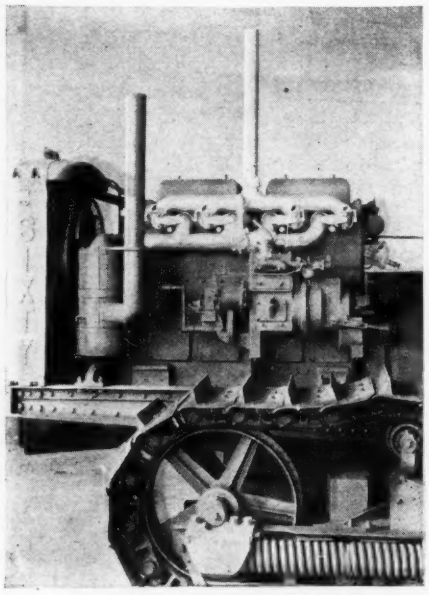


Fig. 6—Diesel engine developed by the Caterpillar Traction Corporation

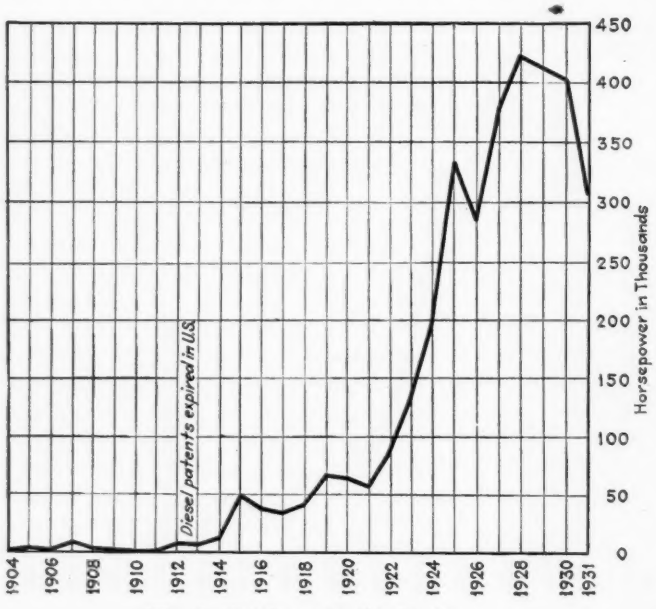


Fig. 7—Total yearly diesel sales

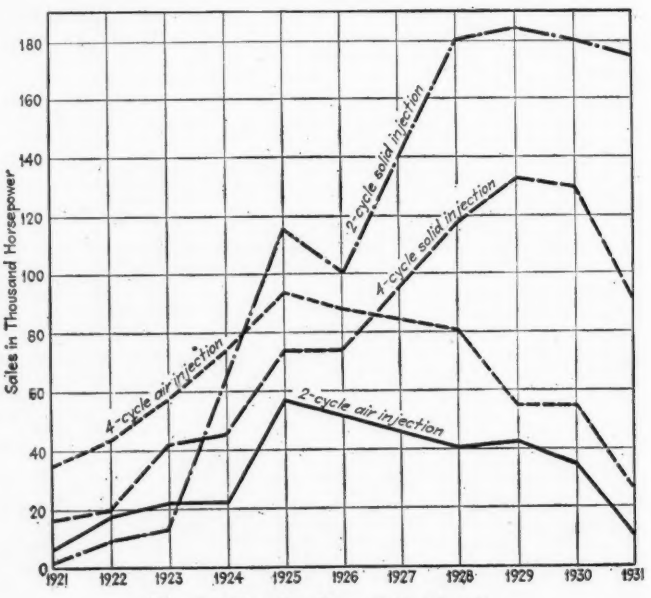


Fig. 8—Classification of diesel sales

Tiger Creek Plant of the Pacific Gas & Electric Company has two 36,000-hp. units for operation under 1,190-ft. head

Hydro-Electric Prospects Exceed Expectations

Water-power plants with an aggregate capacity of over 900,000 hp. put into operation in the United States and 700,000 hp. in Canada during 1931

HYDRO-ELECTRIC progress in 1931 was distinguished by several unusual events. Some of these were favorable; others were not. In point of plant capacity brought into service, 1931 compared favorably with 1930, the figures being about 900,000 and 1,000,000 hp., respectively. In considering these figures it should not be overlooked that during these two years one manufacturer in this country has been working on a contract for 756,000 hp. of waterwheel equipment for the government of Soviet Russia, that is being installed on the Dneiper River.

During the last twelve months water-power developments have been adversely affected by the unsettled business conditions as have all other industries. This is not on account of lack of interest in these prospects, but because of the large decrease in power demands. In 1929 the power generated by public utility stations in this country was 97 billion kilowatt-hours; in 1930 the output of these plants dropped to 95 billion kilowatt-hours; and last year was about 92 billion kilowatt-hours. This loss in power output has not been distributed equally, and some sections have been affected more adversely than others. Some localities suffering the largest percentage of decrease are those supplied largely by hydro-electric plants.

The latter has had two effects. One has been to reduce the output of hydro plants and the other has been to retard hydro-plant construction. In several instances where considerable work has been done on hydro-electric projects, construction has been temporarily abandoned until prospects for power demands improve. As a result waterwheels contracted for last year represented less than 150,000 hp. On the other hand, the plant capacity brought into operation was one of the largest on record, as indicated by the table on pages 24 and 25.

A study of this table shows clearly that interest is not lacking in water-power developments. This table lists only projects that were completed in 1931 or are under construction. In a few instances the initial operation of the plants is given as of 1930. In these the first unit was started near the close of the year and the plant was not completed until in 1931.

Even though there has been a falling off in orders for water-wheel equipment in the last twelve months, the interest in these developments has not lagged, as evidenced by the table of proposed developments. In this table are listed important projects that received attention during the year. Some of these will probably not reach the construction stage for several years, but others are expected to be started during 1932.

In the early part of last year contract was let by the United States Bureau of Reclamations, to construct the

Hydro-Electric Projects Completed and Under

Company	Designing Engineers	Project	[2]New or Redevelop	River	State	Project Started	[1]Initial Operation	Initial Capacity, Hp.	Added Capacity, Hp.	Ultimate Capacity, Hp.	No. of Units Installed
New England States											
Central Maine Pwr. Co.	N. E. Public Service Co.	Wyman	New	Kennebec	Me.	1928	1930	68,000	.....	102,000	2
Grafton Pwr. Co.	N. E. Pwr. Eng. & Service Corp	McIndoes	New	Conn.	N. H.	1930	1931	16,500	.....	16,500	4
Holyoke Water Pwr. Co.	Holyoke Water Pwr. Co.	No. 8	New	Conn.	Mass.	1931	1931	6,000	.....	6,000	1
Middle Atlantic States											
Safe Harbor Water-Pwr. Corp.	Pennsylvania Water-Pwr. Co.	Safe-Harbor	New	Susquehanna	Penn.	1929	1931	255,000	.....	510,000	6
								Station-	Service-	Units	2
Beebe Island Corp.	Buffalo Niagara & Eastern Pwr. Corp.	Beebe-Island	New	Black	N. Y.	1931	1932	10,000	.....	10,000	2
F. L. Emerson	A. E. Ballin	Big Dam	Redev.	Owasco	N. Y.	1931	1932	1,100	.....	1,100	1
F. L. Emerson	A. E. Ballin	Dunn&McCarthy	Redev.	Owasco	N. Y.	1931	1932	1,000	.....	1,000	1
Passaic Valley Water Com.	Fuller & Barbour	Little Falls	Redev.	Passaic	N. J.	1931	1932	3,400	.....	3,400	4
W. Va. Pulp & Paper Co.				Hudson	N. Y.	1931					2
Lamoka Power Corp.		Keuka	New		N. Y.	1931	1932	3,000	7,000	30,000	2
East North Central States											
Consumers Pwr. Co.	Allied Engineers, Inc.	Hardy Dam	New	Muskegon	Mich.	1929	1931	44,400	.....	44,400	3
Baraga Co. Lt. & Pwr. Co.	Holland, Ackerman & Holland	Prickett	New	Sturgeon	Mich.	1931	1931	3,200	.....		2
Willow River Pwr. Co.					Wisc.	1931	.....	350	.....		2
Edison Sault Elec. Co.								2,400	.....		1
West North Central States											
Union Elec. Lt. & Pwr. Co.	Stone & Webster Engr. Corp.	Osage	New	Osage	Mo.	1929	1931	201,000	.....	268,000	6
								Station-	Service-	Units	2
Missouri Elec. Pwr. Co.	Management & Eng. Corp.	Niangua	New	Niangua	Mo.	1929	1930	4,028	.....	4,028	2
Ottumwa Water Works.	Brown Eng. Co.	Mun. Hydro. Elec	New	Des Moines	Iowa	1930	1931	4,500	.....	4,500	3
South Atlantic States											
New Kanawha Pwr. Co.		Hawks Nest	New	New	W. Va.	1930	1932	140,000	.....	140,000	4
Appalachian Elec. Pwr. Co.	Mead & Scheidenhelm / Am. Gas & Elec. Co.	Reusens	Redev.	James	Va.	1930	1931	16,100	.....	16,100	5
Virginia Elec. & Pwr. Co.					Va.			1,150	.....	1,150	1
City of Martinsville	Saville & Williamson		Redev.	Smith	Va.	1931	1932	1,865	.....		1
Georgia Pwr. Co.	Georgia Pwr. Co.	Furman Shoals	New	Oconee	Ga.	1930	.....	60,000	.....	60,000	2
Toccoa Elec. Pwr. Co.	J. G. White Eng. Corp. / Stevens & Wood, Inc. / Allied Engineers, Inc.	Blue Ridge	New	Toccoa	Ga.	1925	1931	30,000	.....	30,000	1
Nantahala Pwr. & Lt. Co.	Aluminum Co. of America	Nantahala	New	Nantahala	N. C.	1929	.....	56,000	.....	56,000	1
West South Central States											
Arkansas Pwr. & Lt. Co.	Elec. Bond & Share Co.	Carpenter	New	Ouachita	Ark.	1929	1931	79,000	.....	118,500	2
Central Tex. Hydro. Elec. Co.		Hamilton	New		Tex.	1931	.....	30,000	.....		2
Central Pwr. & Lt. Co.	Harza Engrg. Co.	Eagle Pass	New	Rio Grande	Tex.	1931	1932	13,500	.....	13,500	3
Texas Pr. & Lt. Co.	Texas Pwr. & Lt. Co.	Llano	Redev.	Llano	Tex.	1930	1931	690	.....	690	1
Texas Hydro-Elec. Corp.	Fargo Eng. Co.	TP 4	New	Guadalupe	Tex.	1931	1932	3,320	.....	3,320	1
Texas Hydro-Elec. Corp.	Fargo Eng. Co.	H 4	New	Guadalupe	Tex.	1930	1931	2,940	.....	2,940	1
Texas Hydro-Elec. Corp.	Fargo Eng. Co.	H 5	New	Guadalupe	Tex.	1930	1931	3,100	.....	3,100	1
Mountain States											
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Hoover Dam	New	Colorado	Ariz.,Nev.	1931	1937	.....	.....	1,000,000	
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Shoshone	New	Shoshone	Wyo.	1930	1931	2,200	6,000	8,200	3
Montana Pwr. Co.		Flathead	New		Mont.	1930	.....	156,000	.....	234,000	
Murray City Mun. Pwr. Plant	Bletzacker & Bletzacker	Murray City	New	Cotton Wood	Utah	1931	1931	1,668	.....	1,668	2
Pacific Coast States											
City of Seattle	Lighting & Eng. Dept's.	Diablo	New	Skagit	Wash.	1927	1932	166,000	.....	320,000	2
City of Tacoma	Public Utilities Dept.	Cushman No. 2	New	Skokomish	Wash.	1929	1930	75,000	.....	112,500	2
Inland Pwr. & Lt. Co.	Elec. Bond & Share Co.	Ariel	New	Lewis	Wash.	1929	1931	55,000	.....	220,000	1
Puget Sound Pwr. & Lt. Co.	Stone & Webster Eng. Corp.	Rock Island	New	Columbia	Wash.	1930	1931	84,000	.....	210,000	4
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Wippel	New	Yakima	Wash.	1931	1932	1,000	.....	.....	2
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Prosser	New	Yakima	Wash.	1931	1932	4,200	.....	4,200	1
Portland Gen. Elec. Co.	Portland Gen. Elec. Co.	Oak Grove	New	Clackamas	Ore.	1929	1931	35,000	40,000	115,000	2
Calif. Oregon Pwr. Co.	Byllesby Eng. & Mgmt. Co.	Prospect No. 3	New	Rogue	Ore.	1931	1932	10,000	.....	10,000	1
Pacific Gas & Elec. Co.	Pacific Gas & Elec. Co.	Tiger Creek	New	Mokelumne	Calif.	1928	1931	72,000	.....	72,000	2
Pacific Gas & Elec. Co.	Pacific Gas & Elec. Co.	Salt Springs	New	Mokelumne	Calif.	1928	1931	13,500	.....	50,000	1
City of Los Angeles	Dept. of Water & Pwr.	San Francisquito	New		Calif.	1931	1932	40,000	22,500	62,500	3
Alaska											
Portland Canal Pwr. Co.	Willis T. Batcheller	Davis River	New	Davis	Alaska	.....	1933	20,000	.....	60,000	2
Panama Canal Zone											
U. S. Panama Canal	U. S. Bureau of Reclamation	Madden Dam	New	Madden	Panama	1931	.....	22,400	.....	33,600	2
Foreign Countries											
Government of Soviet Russia	Hugh L. Cooper & Co.	Dnieper	New	Dnieper	.....	1927	1933	756,000	.....	756,000	9
Canada					**Province**						
Shawinigan Water & Pwr. Co.	Power Engrg. Co.	Rapide Blanc	New	St. Maurice	Que.	1930	1932	160,000	.....	240,000	4
Shawinigan Water & Pwr. Co.	Power Engrg. Co.	La Gabelle	New	St. Maurice	Que.	.....	1931	132,000	33,000	165,000	5
St. John River Pwr. Co.	H. G. Acres & Co.	Grand Falls	New	St. John	N. B.	1926	1931	60,000	20,000	80,000	4
Beauharnois Lt., Ht. & Pwr. Co.	W.S. Lee, T.H. Hogg & F.B. Brown	Beauharnois	New	St. Lawrence	Que.	1929	1932	212,000	.....	636,000	4
								Station-	Service-	Units	2
Alcoa Pwr. Co., Ltd.	Alcoa Pwr. Co., Ltd.	Chute-a-Caron	New	Saguenay	Que.	1927	1931	260,000	.....	260,000	4
Hydro-Elec. Pwr. Comm. of Ont. & Ottawa Valley Pwr. Co.	Chats Falls Eng. Board	Chat Falls	New	Ottawa	Que. and Ont.	1929	1931	224,000	.....	280,000	8
Gatineau Pwr. Co.		Paugan	New	Gatineau	Que.	1926	1928	204,000	34,000	272,000	7
MacLaren Quebec Pwr. Co.	Hardy S. Ferguson & Co.	Masson	New	Lievre	Que.	1931	1933	136,000	....	136,00	4
Northern Ont. Pwr.	Power Corp. of Canada	Upper Notch	New	Montreal	Ont.	1929	1930	13,000	.....	13,000	2
Hydro-Elec. Pwr. Comm. of Ont.	Hydro-Elec. Pwr. Comm. of Ont.	Alexander	New	Nipigon	Ont.	1926	1930	54,000	.....	72,000	3
Ontario Pwr. Service Corp.	George F. Hardy	Abitibi Canyon	New	Abitibi	Ont.	1930	1932	330,000	.....	330,000	5
City of Winnipeg	City of Winnipeg, Eng. Dept.	Slave Falls	New	Winnipeg	Man.	1929	1931	24,000	.....	96,000	2
								Station-	Service-	Units	2
Northwestern Pwr. Co., Ltd.		Seven Sisters	New	Winnipeg	Man.	1929	1931	112,500	.....	225,0	06
Powell River Co., Ltd.	B. C. Condit and Powell River Co.	Lois River	New	Lois	B. C.	1929	1931	24,000	.....	48,00	06
British Columbia Pwr. Corp.	British Columbia Pwr. Corp.	Ruskin	New	Stave	B. C.	1929	1930	47,000	.....	188,0	06
British Columbia Pwr. Corp.	British Columbia Pwr. Corp.	Bridge River	New	Bridge	B. C.	1927	.....	56,000	.....	560,00	3
W. Kootenay Pwr. & Light Co.		Corra Linn	New		B. C.	1930	1932	57,000	.....		

[1]A. C. —Allis-Chalmers Mfg. Co.
M. S. —S. Morgan Smith Co.
J. L. —James Leffel & Co.
I. P. M. —Baldwin Southwark Corp., I. P. Morris Division.
N. N. —Newport News Shipbuilding & Dry Dock Co.
P. W. —Pelton Water Wheel Co.
W. —Woodward Governor Co.
L. —Lombard Governor Co.
G. E. —General Electric Co.
W. E. —Westinghouse Elec. & Mfg. Co.
E. M. —Electric Machinery Mfg. Co.
D. E. W. —Dominion Engineering Works
C. A. C. —Canadian Allis-Chalmers Co.
M. S. I. —S. Morgan Smith-Inglis Co.
C. W. E. —Canadian Westinghouse Co.
C. G. E —Canadian General Electric Co.
S. G. E. —Swedish General Electric Co.

Construction in the United States and Canada in 1931

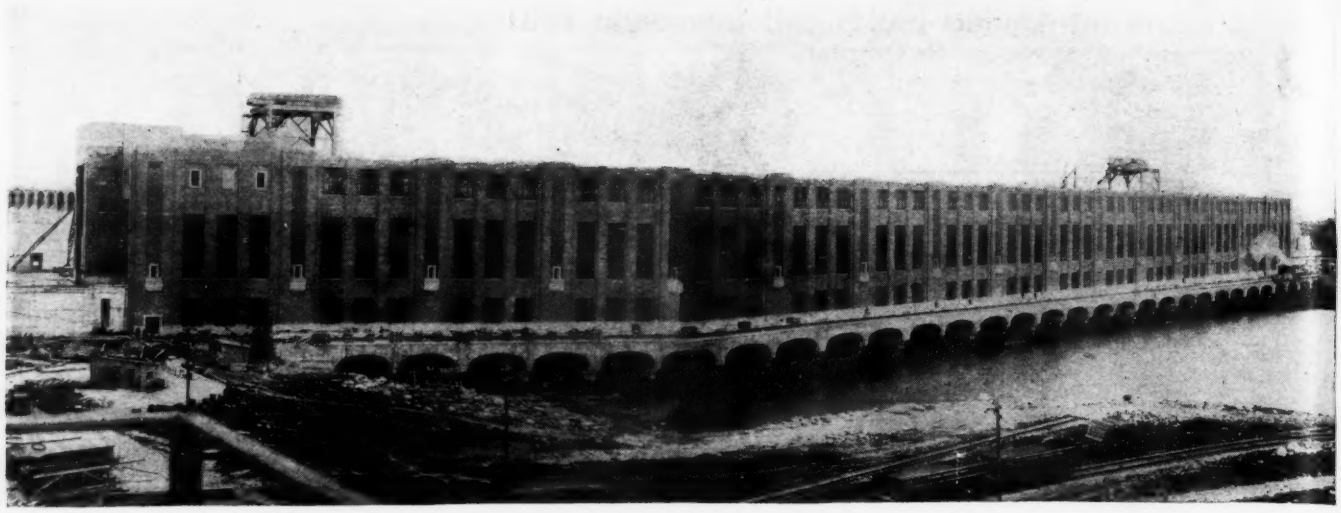
No. of Units Installed	Waterwheel Capacity, Hp.	Type	Speed R.p.p.m.	Static Head, Ft.	Design Head, Ft.	[1]Waterwheel Manuf.	[1]Governor	Draft Tube, Type	Scroll Case, Type	Surge Tank	Relief Valve	Generator Capacity, Kva.	[3]Thrust Bearing Location	Power Factor	Kilovolts	Cycles	[1]Generator Manuf.
2	34,000	Francis	138.5	145–120	135	A. C.	A. C.	Elbow	Plate st.	.....	.....	26,667	B. G.	0.90	13.8	60	G. E.
4	4,125	Kaplan	150	31–25	27	M. S.	W.	Elbow	Concrete	.....	.....	3,300	B. G.	0.80	2.3	60	G. E.
1	6,000	Prop.	128	32–15	30	J. L.	W.	Straight	Concrete	.....	.....	5,000	B. G.	0.80	2.3	60	A. C.
6	42,500	Kapaln	109.1	55	55	3-M. S.	W.	Elbow	Concrete	.....	.....	36,000	B. G.	0.80	13.8	60	4-G. E.
2	3,100	Francis				3-I. P. M.	W.	Elbow	Concrete	.....	.....						2-W. E.
2	5,000	1-Kap. 1-Prop	150	32–29	32	I. P. M.	W.	Elbow	Concrete	.....	.....	5,000	.....	0.80	2.4	60	G. E.
1	1,100	Kapaln	257	26	26	M. S.	M. S.	Elbow	.....	.....	.....	1,000	.....	0.80	2.4	60	G. E.
1	1,000	Kaplan	257	23.5	23.5	M. S.	M. S.	Elbow	.....	.....	.....	875	.....	0.80	2.4	60	G. E.
4	850	3-Prop. 1-Kap..	360	33.5	32	A. C.	A. C.	Elbow	Concrete	.....	.....	750	A. G.	0.80	2.4	60	A. C.
2	1,445	.....	214	24	24	M. S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	7,000	.....	.....	390	385	J. L.	W.	.....	.....	.....	.....	6,250	.....	0.80	2.3	60	E. M.
3	14,800	Francis	163.6	99–85	99	I. P. M.	W.	Elbow	Plate st.	.....	.....	12,500	A. G.	0.80	7.5	60	G. E.
2	1,600	Francis	257	55	54	M. S.	M. S.	Cone	Plate st.	.....	.....	1,375	A. G.	0.90	2.3	60	A. C.
2	275	.....	150	18	18	M. S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	2,400	Prop.	128.5	17	17	A. C.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	33,500	Francis	112.5	106–65	90	A. C.	A. C.	Elbow	Plate st.	.....	.....	23,888	B. G.	0.9	13.8	60	W. E.
2	3,025	Francis	.....	.....	90	A. C.	A. C.	Elbow	Plate st.	.....	.....	3,000	.....	0.7	2.4	60	W. E.
2	2,014	Kaplan	327	44	44	M. S.	W.	Elbow	Concrete	.....	.....	1,750	B. G.	0.80	2.3	60	A. C.
3	1,500	Prop.	112.5	12.5	12.5	A. C.	W.	Hy'cone	.....	.....	.....	1,250	A. G.	0.80	2.2	60	A. C.
4	35,000	Francis	150	.....	157	I. P. M.	.....	.....	.....	.....	.....	30,000	B. G.	0.85	6.9	25	W. E.
5	3,620	.....	164	35–13	32	J. L.	W. & L.	.....	.....	.....	.....	3,125	B. G.	0.80	4.0	60	3-G. E.
																	2-W. E.
1	1,150	.....	180	.....	29.5	M. S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	1,350	Kaplan	300	30	30	M. S.	M. S.	.....	.....	.....	.....	1,250	A. G.	0.80	4.0	60	G. E.
1	515	Francis	277	30	30	M. S.	M. S.	.....	.....	.....	.....	375	A. G.	0.80	4.0	60	G. E.
2	30,000	Francis	100	92–45	92–45	M. S.	M. S.	Elbow	.....	.....	.....	25,000	B. G.	0.90	6.9	60	G. E.
1	30,000	Francis	163	150–77	147–75	M. S.	W.	Elbow	Plate st.	Johnson	.....	25,000	B. G.	0.80	12.5	60	W. E.
1	56,000	Francis	512	965	920	.....	.....	Elbow	Cast st.	Diff.	.....	45,000	A. G.	0.90	13.0	60	.....
2	39,500	Francis	94.7	95–80	89	I. P. M.	I. P. M.	Moody	Plate st.	.....	.....	31,111	B. G.	0.90	13.8	60	A. C.
2	15,000	Francis	171.4	126	.....	M. S.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	4,500	Francis	225	81	81	J. L.	W.	Elbow	Plate st.	.....	.....	3,200	B. G.	0.80	6.9	60	W. E.
1	690	Kaplan	427	15–13.5	15–13.5	M. S.	W.	Elbow	Concrete	.....	.....	625	A. G.	0.80	2.4	60	W. E.
1	3,320	Kaplan	180	29	29	M. S.	M. S.	Elbow	Flume	.....	.....	3,000	.....	0.80	2.3	60	G. E.
1	2,940	Kaplan	180	26.5	26.5	M. S.	M. S.	Elbow	Flume	.....	.....	3,000	.....	0.80	2.3	60	G. E.
1	3,100	Kaplan	180	27.5	27.5	M. S.	M. S.	Elbow	Flume	.....	.....	3,000	.....	0.80	2.3	60	G. E.
.....	.....	.....	.....	584–422	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	6,000	Francis	360	227–175	190	N. N.	W.	Conical	Steel	.....	.....	5,000	A. G.	.....	2.3	60	W. E.
.....	78,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	834	Impulse	720	593	563	M. S.	W.	.....	.....	.....	Hawley	625	.....	0.8	2.3	60	W. E.
2	83,000	Francis	171.5	327–247	310	M. S.	M. S.	Elbow	Cast st.	Johnson	Pres. Reg.	66,700	A. G.	0.90	13.8	60	W. E.
2	37,500	Francis	300	484	440	A. C.	A. C.	Hy'cone.	Cast st.	Johnson	Gov. Op.	30,000	A. G.	0.90	13.2	60	A. C.
1	55,000	Francis	120	185–160	170	M. S.	M. S.	Elbow	Plate st.	.....	.....	56,250	B. G.	0.80	13.8	60	G. E.
4	21,000	Prop.	100	51–20	32	A. C.	A. C.	Elbow	Concrete	.....	.....	16,667	B. G.	0.90	13.8	60	G. E.
2	500	[5]Note	500	87	83	N. N.	.....	Conical	Cast iron	.....	.....	.....	.....	.....	.....	.....	.....
1	4,200	Prop.	200	42–32	40	N. N.	W.	Elbow	Plate st.	.....	.....	3,750	A. G.	0.80	2.4	60	G. E.
2	40,000	Francis	514	935	850	P. W.	P. W.	Moody	Cast st.	Johnson	Gov. Op.	30,000	A. G.	0.85	11.0	60	G. E.
1	10,000	Francis	720	720	697	P. W.	P. W.	.....	Cast St.	.....	Gov. Op.	9,000	A. G.	0.80	6.9	60	A. C.
2	36,000	Impulse	225	1,218	1,190	P. W.	P. W.	.....	.....	.....	.....	30,000	.....	0.85	11.0	60	W. E.
1	13,500	Francis	300	244	240	P. W.	P. W.	Elbow	Cast st.	.....	.....	11,000	A. G.	0.85	11.0	60	W. E.
3	22,500	Francis	428	540	530	N. N.	W.	Conical	Cast st.	.....	Gov. Op.	17,500	A. G.	0.80	6.6	60	A. C.
2	.....	Francis	450	.....	400	.....	.....	Elbow	.....	.....	.....	15,000	A. G.	0.80	6.6	60	.....
2	11,200	Francis	214.2	145–75	120	.....	.....	Elbow	.....	.....	.....	10,000	.....	0.80	6.9	25	.....
9	84,000	Francis	88.2	123–96	.....	N. N.	W.	Elbow	Plate st.	.....	.....	77,500	A. G.	0.80	13.8	50	G. E.
4	40,000	Francis	109.1	117–93	108	D. E. W.	D. E. W.	Moody	Plate st.	.....	.....	36,000	B. G.	0.85	11.0	60	C. W. C.
5	33,000	Prop.	120	60	60	D. E. W.	D. E. W.	Moody	Concrete	.....	.....	33,000	A. G.	0.80	6.6	60	C. W. C.
4	20,000	Francis	163.6	133	125	C. A. C.	W.	Moody	Plate st.	Johnson	.....	17,500	A. G.	0.90	6.6	60	C. G. E.
4	53,000	Francis	75	83	80	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	46,625	B. G.	0.80	13.2	60	C. G. E
2	8,000	Francis	180	83	80	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	7,200	.....	0.80	13.2	60	C. G. E.
4	65,000	Francis	120	165	150	M. S. I.	W.	Elbow	Plate st.	.....	.....	50,000	A. G.	0.80	13.2	60	C. W. C.
8	28,000	Prop.	125	58–38	53	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	23,500	A. G.	0.85	13.2	25	C. W. C.
7	34,000	Francis	125	136	132	D. E. W.	W.	Moody	Plate st.	.....	.....	28,500	A. G.	0.80	6.6	25	C. W. C.
4	34,000	Francis	166.7	203–186	185	C. A. C.	W.	Elbow	Plate st.	Johnson	.....	28,000	A. G.	0.85	13.2	60	C. W. C.
2	6,500	Francis	137	45	45	C. A. C.	C. A. C.	.....	Concrete	.....	.....	6,500	A. G.	.....	11.0	25	S. G. E.
3	18,000	Francis	100	64	60	M. S. I.	W.	Elbow	Concrete	.....	.....	15,000	A. G.	0.85	12.0	25	C. G. E.
5	66,000	Francis	150	.....	237	C. A. C.	C. A. C.	.....	Plate st.	.....	.....	.....	.....	.....	.....	.....	.....
2	12,000	Prop.	94.7	33–22	30	D. E. W.	W.	Moody	Concrete	.....	.....	10,000	A. G.	1.00	6.6	60	S. G. E.
2	500	Prop.	450	33–22	30	D. E. W.	W.	.....	.....	.....	.....	450	A. G.	.....	0.22	60	S. G. E.
00	37,500	Prop.	138.5	66	66	D. E. W. C. A. C. M. S. I.	.....	.....	.....	.....	.....	32,500	A. G.	0.85	11.0	60	.....
0(	24,000	Francis	333.3	425–300	410–300	D. E. W.	W.	Moody	Plate st.	Johnson	.....	18,000	A. G.	0.80	6.6	50	C. G. E.
0(	47,000	Francis	120	130	123	D. E. W.	W.	Moody	Plate st.	.....	.....	44,000	B. G.	0.80	13.2	60	C. W. C.
1	56,000	Impulse	.....	1,224	1,097	.....	.....	.....	.....	.....	.....	45,000	.....	0.90	13.2	60	.....
3	19,000	.....	85.7	53	53	D. E. W.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*The term "New" applies to an entirely new project on a site that has not been developed previously. "Redevelop" indicated a project on a site that has been developed previously and may consist of new wheels and settings on an entirely new plant.

[3]A. G. indicates that the thrust bearing is above the generators rotor; B. G., thrust bearing located below the rotor.

[4]There are a few plants in the table that have their initial operation given as of 1930 In these plants the first unit was started late in the year and the initial installation in the plant was completed in 1931.

[5]These two wheels are of the horizontal-shaft type and connect directly to pumps.



Power house of the Beauharnois Power Corporation on the St. Lawrence River which will house over 500,000 horsepower

Hoover Dam project. This is the largest single project of its kind in the United States. It comprises the highest dam in the world, being 730 ft. high from its foundation to its crest, and will have a power installation of about 1,000,000 hp. This work is now well under way, but contracts for power house equipment will probably not be let before 1933. In addition to the power house equipment, forty 72-in. free-discharge valves and eight 72x 75-in. gate valves will be required.

Hoover Dam has made possible the water-supply project for the Metropolitan Water-Supply District of Southern California. This development will eventually deliver one billion gallons of water per day to cities in southern California, and will require 400,000 hp. of pumping equipment. There will also be large water-power installations on this system.

Model tests to check the design of hydro-electric projects have a wide acceptance among engineers. These tests are being applied to all parts of the structure. All the large waterwheel manufacturers have their own hydraulic laboratories. Several of the universities have extensive facilities for making model and other hydraulic investigations. At least two power companies in the United States and one in Canada have their own hydraulic laboratories. The improvements in design that have resulted from tests made in these laboratories have many times emphasized the economic value of these facilities and the work done in them.

Last year plans were completed for a National Hydraulic Laboratory at the United States Bureau of Standards in Washington, D. C. It is expected that this laboratory will be ready for service near the end of this year.

PROPOSED HYDRO-ELECTRIC PROJECTS*

United States

Company	Company Address	River	State	Estimated Cost† or Hp.
Cumberland County Pwr. & Lt. Co	Portland, Me.	Saco	Me.	$450
New York State	Albany, N. Y.	St. Lawrence	N. Y.	$100,000
West Penn Pwr. Co	Pittsburgh, Pa.	Allegheny	Pa.	31,000
Eel River Pwr. Co	Indianapolis, Ind.	Eel	Ind.	24,000
Ford Motor Car Co	Dearborn, Mich.	Huron	Mich.	$2,000
Missouri Elec. Pwr. Co	Dubuque, Iowa	Niangua	Mo.	$700
Empire District Elec. Co	Joplin, Mo.	White	Mo.	$35,000
Copper District Pwr. Co.	Calumet, Mich.	Lake Gogebic	Mich.	$400
Appalachian Elec. Pwr. Co	Roanoke, Va.	New	Va.	$11,000
W.Va. Pwr. & Transmission Co.	Pittsburgh, Pa.	Cheat	W.Va.	$77,000
Appalachian Elec. Pwr. Co	Roanoke, Va.	Kanawha	W.Va.	$5,000
Peoples Lt. & Pwr. Corp	New York City	Dan	N.C.	$8,000
Columbia Ry. & Nav. Co	Columbia, S. C.	Santee	S.C.	$10,000
Southern Industries & Util. Inc.	Chattanooga, Tenn.	Tennessee	Tenn.	$35,000
Mountain Pwr. Co	Chattanooga, Tenn.	Tellico	Tenn.	55,000
Holston River Pwr. Co	Johnson City, Tenn.	Holston	Tenn.	34,500
Arkansas Pwr. & Lt. Co	Little Rock, Ark.	Ouachita	Ark.	$2,000
Arkansas Pwr. & Lt. Co	Little Rock, Ark.	White	Ark.	168,000
Grand River Pwr. Co	Tulsa, Okla.	Grand	Okla.	$2,000
City of Idaho		Shake	Idaho	40,000
Columbia River Pwr. Co	Seattle, Wash.	Columbia	Wash.	$15,000
Great Northern Pwr. Co.	Seattle, Wash.	Skykomish	Wash.	$2,000
Backus Brooks Co.	Minneapolis, Minn.	Cowlitz	Wash.	$3,000
Hugh L. Cooper & Co.	New York, N. Y.	Columbia	Wash.	60,000
Calif.-Oregon Pwr. Co.	Medford, Ore.	Klamath	Calif.	40,000
Calif.-Oregon Pwr. Co.	Medford, Ore.	Umpqua	Ore.	$29,650
Turlock Irrigation Dist.	Turlock, Calif.	Merced	Calif.	$7,000
Consolidated Irrigation Dist.	Selma, Calif.	San Joaquin	Calif.	$10,000
Metropolitan Water Dist. of S. Calif.	Los Angeles, Calif.	Colorado		136,000
Canada			**Province**	
Ontario Hydro-El. Pwr. Comm.	Toronto, Ont.	St. Lawrence	Ont.	$100,000
Ontario Hydro-El. Pwr. Comm.	Toronto, Ont.	Ottawa	Ont.	300,000
Gatineau Pwr. Co.	Ottawa, Ont.	Ottawa	Que.	
Manitoba Pwr. Comm.	Winnipeg, Man.	Dauphin	Man.	400,000
Dominion Pwr. Co.	Winnipeg, Man.	Nelson	Man.	400,000
Saskatchewan Pwr. Comm.	Regina, Sask.	Saskatchewan	Sask.	$12,200
British Columbia Elec. Ry. Co.		Campbell	B. C.	157,000

*The projects listed in this table are some of the more important that have been given attention during 1931. Some of these projects are in the earlier stages of promotion while application has been made to governmental agencies for a license in order that construction work may be started on others.

†Three cyphers omitted from estimated cost figures.

Propeller and Kaplan Turbines

For heads below 60 ft. the tendency is toward the use of propeller and Kaplan-type turbines. Of the plant capacity put into operation this year in the United States about 100,000 hp. was propeller and 300,000 hp. Kaplan wheels. The horsepower for the latter is unusually high because of the Safe Harbor plant on the Susquehanna River coming into service. In that plant the initial installation is six 42,500-hp. units. These are the highest-power Kaplan wheels in the world and are designed to operate under a 55-ft. head.

The Rock Island plant of the Puget Sound Power & Light Company was the most important installation of propeller-type wheels to go into operation during the last year. These runners are of the fixed-blade type and each of the four units are rated at 21,000 hp. Maximum head will be 50 ft. The highest-powered wheels in the United States are the two Francis type that have a maximum rating of over 90,000 hp. each, being installed by the city of Seattle in its Diablo plant. This record is threatened by those proposed for the Hoover Dam project, with a capacity of 125,000 horsepower.

A second unit has been installed at the Oak Grove plant of the Portland General Electric Co. and a third is to go in. This is the highest-head Francis type unit in operation in the United States, the static head being 935 ft. It will be exceeded by the 56,000-hp. wheel to be installed in the Nantahala Power & Light Company's plant in North Carolina, with a static head of 965 ft.

These high heads for Francis turbines are exceeded by that at the Bringhausen plant in Germany, which is 1,005 feet.

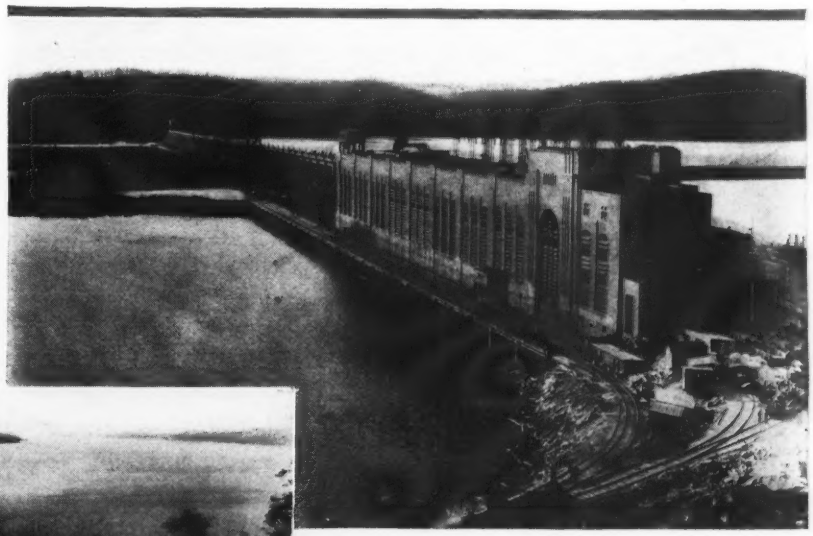
The subject of pumped-storage plants for supplying system peak loads has been receiving increased attention. One manufacturing company in this country has developed an experimental pump-turbine for use in this type of plant. This unit is capable of being used for pumping water into the reservoir during off-peak periods, and by reversing its direction of rotation it can be used to generate power during peak loads. With an 18-in. model, when pumping an efficiency of 85 per cent was obtained, and as a prime mover the efficiency was 89 per cent.

A marked improvement has been made in valve equipment during recent years. Butterfly valves up to 27 ft. in diameter for a 90-ft. head have been in operation for about two years. The experience with these valves has been highly satisfactory. These and several other installations of this type of valve have shown practically negligible leakage when closed, some with test pressures up to over 400 lb. per square inch. Last year at the Ariel plant of the Inland Power & Light Company, a valve of this type, 17 ft. in diameter, to operate under a 180-ft. head, was installed. Another notable installation of these valves are the two 78-in. free-discharge valves for operation under a 300-ft. head at the Salt Springs Dam of the Pacific Gas & Electric Company in California.

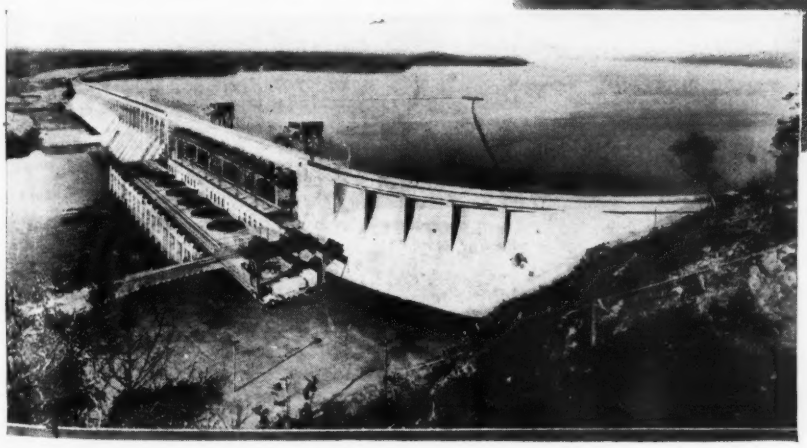
In Canada water-power developments have continued to be active, as indicated by the developments listed in the tables. Last year about 700,000 hp. of plant capacity was put into service. Of this, 360,000 hp. capacity was in propeller-type wheels, all of which are of the fixed-blade type. These wheels are installed in three plants for static heads of 33, 53 and 66 ft. respectively.

Of the large plants now under construction, that of the Ontario Power Service Corporation on the Abitibi River will have the highest-power units so far constructed in Canada. There will be installed in this plant five 66,000-hp. turbines to operate under a 150-ft. head. Construction work on the Beauharnois Power Corporation's plant on the St. Lawrence River was carried well on toward completion. This project includes a power and navigation canal 15 mi. long by 3,000 ft. wide and a power house for 636,000 hp. Ultimately the plant will be extended for an installed capacity of 2,000,000 hp. The initial installation consists of four 53,000-hp. and two 8,000-hp. Francis-type units to operate under an 83-ft. head.

Water-power development in Canada, as in the United States, have been adversely affected by business conditions. Only one important contract for waterwheels was let during the year and included four 34,000-hp. units. There are two or three large projects that give promise of work being started on them during the next twelve months and another is being worked on for which the power equipment contracts have not been let.



Above — Safe Harbor Water-Power Company's plant will have six 42,500-hp. Kaplan wheels in its initial installation



Left—Osage plant of the Union Electric Light & Power Company has six 33,500-hp. units for a 90-ft. head

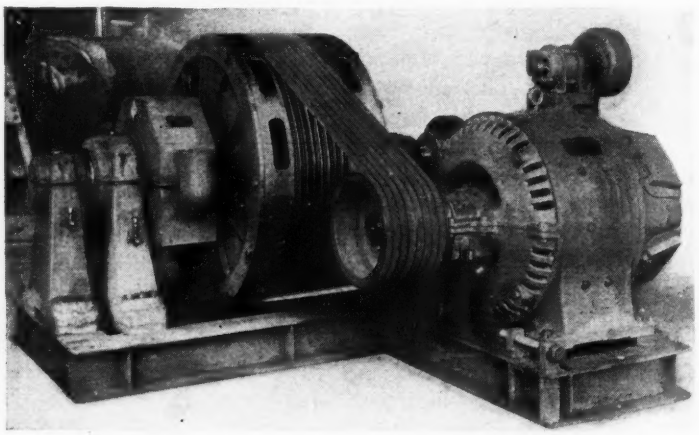
New Records Made In Electrical Power Equipment

Increases in size of equipment; higher speed ranges for steam-turbine-driven generators; new development in mercury-arc rectifiers; and application of synchronous motors are some of the accomplishments

WHILE 1931 will probably be remembered as a depression year, it has many achievements to its credit in the electrical power industry. Many industrialists have taken advantage of the slack period to modernize their plants. A large amount of business has come to the electrical industry from these sources. One manufacturer reports orders for 90,000 hp. of motors for main-roll drives. Another reports construction of steel-mill roll-drive motors of record-breaking size and new developments for modernizing the rolling processes. What has been true of the steel industry applies to many others, so that although the past twelve months have not been all sunshine there have been many bright spots.

In power-generating equipment new records have been established. The 200,000-kva., 1,800-r.p.m. unit installed in the Hudson Avenue station of the Brooklyn Edison Company is more than 50 per cent larger in capacity than any previous generator of corresponding speed. A noticeable achievement was made in the design of the 22,500-kva., 3,600-r.p.m. turbine-driven generator for the Public Service Company of New Jersey. This is the largest generator ever built for that speed. The largest previous machine for this speed was the 18,500-kva. unit reported last year.

Another interesting development in steam turbine-generators are the two 2,000-kw., 180-cycle units for the du Pont company. The power from these generators will be used in motors driving spinning buckets for making artificial silk. By using two-pole motors on 180-cycle power a speed of 10,000 r.p.m. will be obtained. Three machines with ratings of 500, 666 and 750 kva., respectively, have been built for 960-cycle power to supply high-frequency electric furnaces.



In this Rossman drive the d.-c. motor is connected to the stator of the a.-c. motor by a multiple V belt

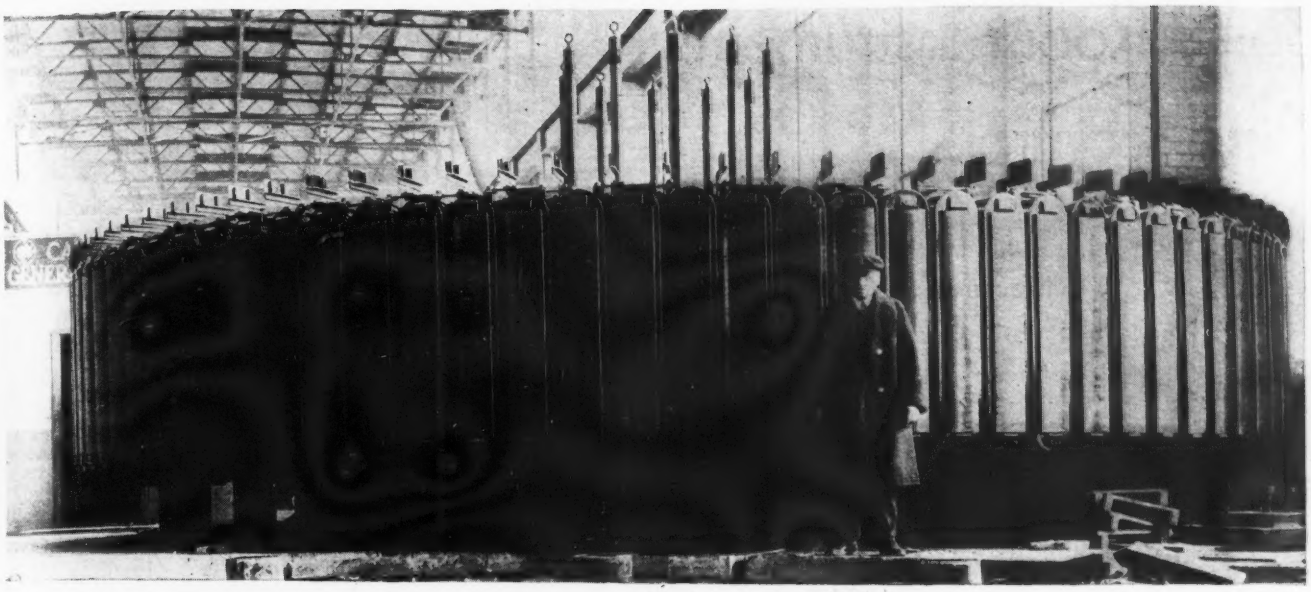
The two 77,000-kva. hydro-electric generators for the Diablo plant of the city of Seattle are the largest on the Western Hemisphere. The table of water-power developments on pages 24 and 25 indicate that last year was an active one in hydro-electric developments and shows a decided tendency to umbrella-type generators with the thrust bearing below the rotor.

Synchronous condensers have been increasing in capacity as the size of systems and their voltage have increased. A 75,000-kva., 314-r.p.m. synchronous condenser is now being built for the Commonwealth Edison Company. This unit is 50 per cent larger than any previously constructed.

The tendency to omit the building over rotating machines has continued to gain favor. Two 21,000-kva. frequency-changer sets at Wayne Junction substation of the Philadelphia Electric Company went into operation during the year and are inclosed in a sheet-steel housing. A 50,000-kva. hydrogen-cooled synchronous condenser was put into operation by the Southern California Edison Company. There is now over 200,000-kva. capacity of hydrogen-cooled synchronous condensers in service or under construction, all of which are for installation out of doors. Air-cooled machines of this type are also being installed outdoors.

A three-phase, 70,000-kva., 60-cycle transformer put into operation by the United Electric Light & Power Company, New York City, is the largest unit of this type built in America. Motor-driven blowers aid the ventilation of its rows of radiators, which are mounted on headers and connected to the transformer tank by large pipes.

Mercury-arc rectifiers continue to gain in favor. These are now built in sizes up to 6,500 kw. for power purposes and are used to supply a wide variety of loads. Improvements in design have greatly added to the reliability of this equipment. A new design was announced during the year in which sectional units are used. A rectifier was built with four sections, each of 750-kw. capacity, assembled to form a 3,000-kw. unit. It is



Rotor for one of the 46,625-kva. 75-r.p.m. generators in the Beauharnois power house, near Montreal

claimed that a sectionalized rectifier of large capacity is less likely to backfire than a single unit of equal capacity.

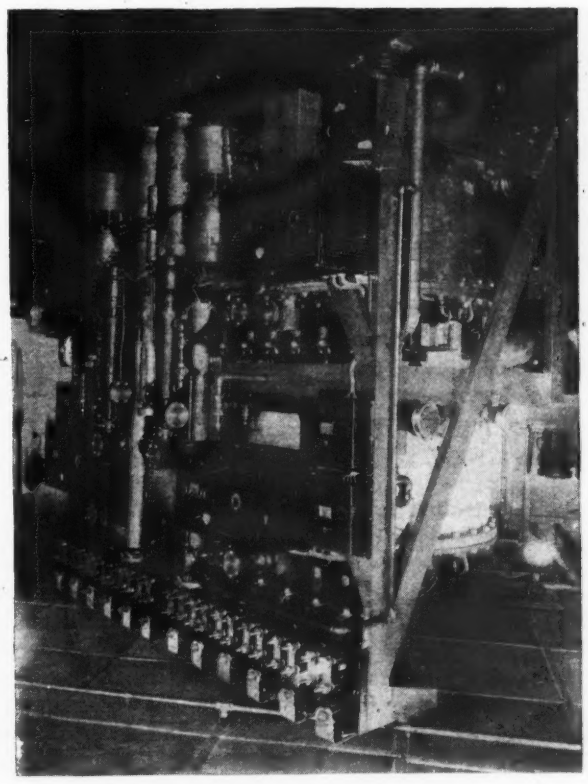
Another company reports that developments during the year have been concentrated on large-capacity rectifiers for which a rapidly increasing demand is felt. Further progress has been made in preventing arc-backs and in the regulation of the direct-current voltage by means of controlled grids. Although not the largest rectifier built, the 2,200-kw. unit for 3,500 to 9,600 direct-current volts, to be used in electro-chemical work, is outstanding.

As the starting, accelerating and pull-in requirements of synchronous motors become better understood their application is being extended to new fields. The best example of how well the problem of starting these motors has been solved is the 600-hp., 440-volt, 300-r.p.m. motor that has been applied to continuous reversing duty on a copper-rolling mill. Last year several applications of synchronous motors, some of 5,000-hp. capacity, were made on steel-rolling mills. A two-speed, 700-hp., vertical synchronous motor was installed on a pump for the Ford Motor Company.

Part-winding starting, developed in 1930, has been used extensively in the last twelve months for various types of synchronous motor applications. The part-winding system makes use during starting of multiple circuits in the stator winding. These circuits are connected to the line individually to provide starting current increments until finally the entire winding is connected. This type of starting is used, in general, to provide the equivalent of reduced voltage starting where this is necessary with high-speed motors.

An installation of synchronous motors was made to grain-elevator applications. The motors are inclosed, pipe-ventilated, fan-cooled and are reported to be the first of their kind in this country. An interesting and unusual application of synchronous motors was made by New Orleans Sewage and Water Board. Two sets of two 2,500-kva. synchronous motors were installed for multiple duty. In addition to driving direct-connected pumps they may also be used as frequency changers.

Control side of a 3,000-kw. mercury-arc rectifier made in four sections



Last year a new system of speed control for alternating-current motors was announced, which is a combination alternating- and direct-current system, consisting of a drive and regulating unit. The drive unit includes a constant-speed alternating-current motor, either induction or synchronous type, and an adjustable-speed direct-current motor. The stator and rotor of the alternating-current motor are mounted in bearings and the direct-current motor is connected mechanically to the stator. Wider applications were reported in 1931 for this drive, which is particularly applicable to driving power house auxiliaries.

Boiler Room Instruments And Controls

Manufacturers of boiler accessories have kept pace with the increase in pressures and temperatures. Gages and flow meters are now available for 5,000-lb. pressure. More sensitive feed-water control for high-pressure, high-capacity boilers and improved testing equipment for feed-water conditioning were brought out during the year

THE steadily increasing use of higher pressures and temperatures in the power plant has brought new demands upon the gage, instrument and control manufacturers. That these demands are being met is indicated by the rather extensive line of equipment brought out during 1931.

Pressure gages are now available for pressures up to 5,000 lb. and designed especially to withstand high temperatures as well as severe vibrations and pulsations in service. In these gages the tube is bored from a solid bar of alloy steel rolled to shape and radius, then heat-treated. Sector and pinion are wide-faced and the teeth are hardened and chromium plated to resist wear. To make possible the locating of pressure indicators and recorders at considerable distance from the pressure source a selsyn-operated gage has been developed. A power-type pressure device operating a selsyn motor is connected to the pressure and this is, in turn, connected by means of wires to the selsyn-operated indicators or recorders in any desired location. Twelve or more instruments may be connected in the same master pressure circuit.

As a supplement to the standard indicating pressure gage, a device known as a pulsation dampener has been introduced. In one of these units a rubber-bulb pressure-transmitting element is incorporated, which serves to protect the gage against the action of acid or other chemicals.

Recording thermometers designed to eliminate the effects of ambient temperatures, and pyrometers with improved mechanical balancing device and automatic standardizers which check the instrument every 45 min. are recent additions.

Developments in draft gages centered around instruments for the control of combustion on underfeed stokers with zoned air control. Panels containing upward of 40 gages under push-valve control are now available and in some gages two elements have been combined into one unit to conserve panel space.

The increased rate of steaming of modern boilers has necessitated the development of more responsive feed-water controls in order to keep the level within normal limits during large changes in load. One of the recent developments in feed-water regulators employs two thermostats, one of which is influenced by the rate of flow in the steam header and the other by the changes in water level, the two thermostats being connected in series to control the opening of a single feed-line valve. Another type employs three elements, steam flow from the boiler, feed-water flow to the boiler and water level in the drum. The three elements are coordinated by means of linkage to operate a selsyn sending device through a torque amplifier. A selsyn receiver mounted on the feed-water valve operates a pilot valve which, in turn, controls the admission of pressure to a hydraulic cylinder and consequently the opening of the feed-water valve. A system developed especially for use with the once-through series boilers referred to in the section on boiler developments employs the Thyratron vacuum-tube circuit. Changes in pressure operate, through selsyn motors, the contactors in the circuits of two Thyratron tubes which supply power to a reversing direct-current motor on the control valves.

The jet pipe principle of automatic control, used for some time in Europe, was introduced in this country during the year. This control system consists, essentially, of a pump supplying oil under pressure to a jet pipe arranged to oscillate across two closely adjacent nozzles connected to opposing ends of a regulating cylinder that operates the controlling member. Two or more swinging jet units comprise a complete control system.

A number of controllers for reduced pressure, back pressure, boiler gas fuel, and differential pressure were added during the year. In one of these controls which has a wide pressure range the change of leak of the operating medium is effected directly by the movement of a Bourdon tube. In another unit a free vane floating between two air streams controls the pressure admitted to the control valve. Various designs of time and pneumatic cycle controllers were added.

Through the introduction of improved types of comparators the work of phosphate determination in connection with boiler-water conditioning has been greatly simplified and speed and accuracy of analysis are now possible by the boiler operator himself. One of the more recent instruments employs colored glass standards.

Slide-type comparators for pH determination covering a range of 0.2 to 13.6 are now available. This instrument employs three test tubes, and the pH value is read directly from a slide on the front of the instrument. Operating on a similar principle is a comparator for the control of chlorine in water and chlorine treatment to prevent growth of algae, etc., in condensers.

Among the small testing instruments introduced during the year were a special hydrometer for determining the saline concentration of boiler water in which temperature corrections can be read directly in terms of density, and a special instrument designed to show the exact freezing temperature of any calcium chloride brine.

Direct electric heating used in office building of the Southern California Edison Company

Developments in Heating and Ventilating

Attention has been given to improvements in control equipment for orificed heating systems, thermostatic radiator valves and air-conditioning units

CONSIDERABLE interest has been in evidence during the year concerning the application of the refrigerating cycle to building heating. This system contemplates the absorption of heat from the atmosphere and its subsequent liberation to the building heating system at increased temperature. Such an installation has been made in the office building of the Southern California Edison Company, at Los Angeles, Calif. Four 120-ton duplex rotary compressors have been installed as part of the refrigerating equipment in that building. During the winter months the refrigerating system removes heat from the outside air and uses it to heat air supplied to the building at a temperature of 80 deg. This same refrigerating equipment is used during the summer months for air-conditioning purposes. In addition, the building contains direct electric heaters of 1,329 kw. capacity and indirect electric heaters of 1,589-kw. capacity. This is the first application of the refrigerating system to heating a large office building in this country.

The use of orifices to improve the distribution of steam to radiators of heating systems has increased during the year, and there has also been a noticeable trend to the use of centrally controlled heating systems in large installations. In one large office building using orifice distribution and central control the usual radiator traps have been eliminated, thus considerably reducing the cost of the installation. Progress during the year has been almost entirely devoted to the improvement of design details of heating equipment. An example of this is the development of an automatic radiator valve for concealed radiation which is operated by two temperature bulbs, one located so as to be affected by the temperature of the air entering the radiator inclosure and the other by the temperature of the air leaving the cabinet.

Researches at the Harvard School of Public Health have shown that the ionic content of air in occupied rooms falls greatly below the ionic content of fresh outside air. Preliminary investigation seems to indicate that this ionic content in the air has considerable influence on metabolism rate. If subsequent investigation indicates this preliminary finding to be true, changes in methods of air conditioning may be resorted to, such as increasing the amount of air supplied per person, or developing equipment for satisfactorily ionizing the air artificially.

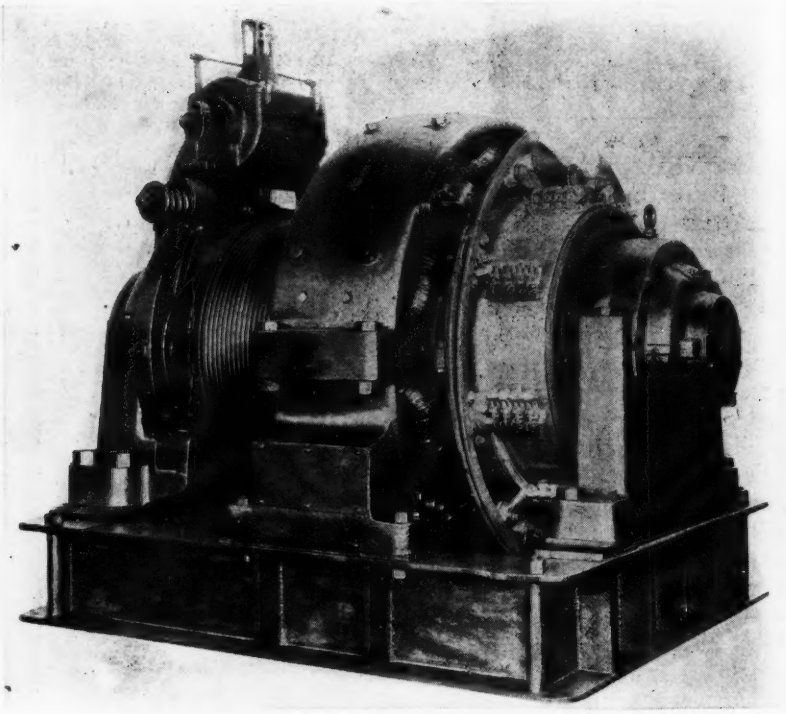
During the year equipment has been developed for air conditioning which uses ice instead of mechanical refrigeration. An atmospheric cabinet, which can be used to replace standard type of radiators, has been designed to heat or cool, humidify or dehumidify.

Silica gel has been used in a number of plants for dehumidifying purposes.

Two large installations of hot water heating were made, one at the Pratt & Whitney Aircraft Corporation plant at Hartford and the other at the Ford museum and technical school, Dearborn, Mich.

The plant at Hartford serves both Pratt & Whitney and the Chance Vought plants. Two 7,500-sq.ft. oil-fired boilers are installed. Water for the heating system is heated in two instantaneous closed vertical heaters and circulated by 4,000-g.p.m. turbine-driven pumps. Exhaust from auxiliaries, supplemented by live steam in severe weather, is used in the heaters. Length of pipe and desire for uniform temperature dictated this system.

At the Ford museum 150-lb.-pressure steam is carried 1,600 ft. from a new boiler plant to three high-pressure heaters which are arranged so that the steam pressure returns the condensate to the boiler plant. This is accomplished by valves in the drain line from each heater, adjustment of which permits control of the tube surface covered by condensate and therefore, of the temperature to which the water is heated. The three heaters will raise the temperature of 6,000 gal. of water per minute 15 deg. and condense 50,000 lb. of steam an hour. They serve a total of 120,000 sq.ft. of radiation.



One of the elevator machines used on the double-deck elevators in the Cities Service Building

New Code Favors Elevator Progress

SEVERAL important events marked elevator progress during the past twelve months. The first of these was a new National Safety Code for Elevators approved by the American Standards Association. Approval of this code by the association followed nearly four years of research on elevator safety devices at the United States Bureau of Standards and extensive investigations by a technical committee of 38 representatives of architectural, engineering, governmental and other organizations.

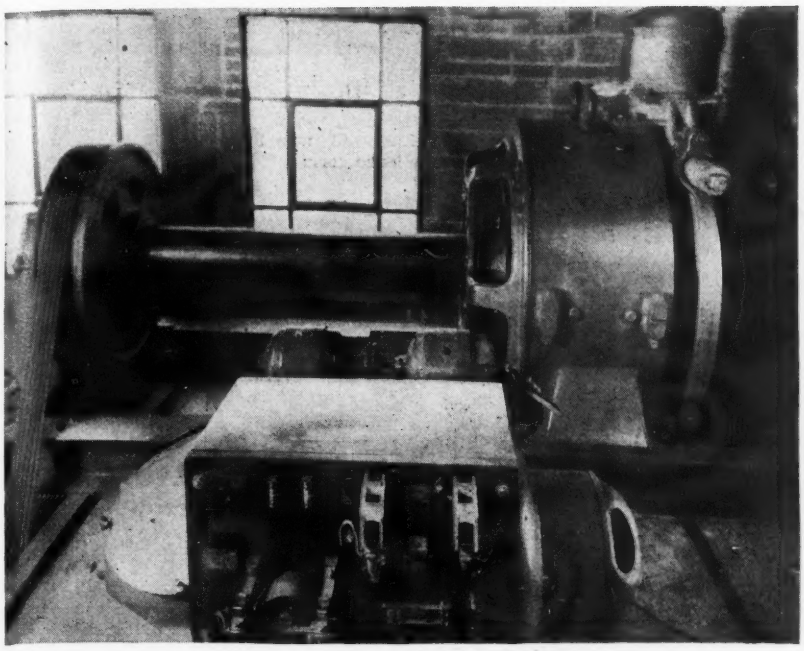
The new code removes practically all restrictions that have stood in the way of rational development in vertical transportation for several years. The revision by New York City of its building code to embody all the important features of the National Elevator Code makes possible large economies in providing elevators in high buildings. In these codes car-speed restrictions are removed. It is now possible to operate elevators up to 1,200 ft. per minute, the maximum for which passenger elevators have been installed. Although the limit has been removed on elevator car speed, experience tends to indicate that 1,200 ft. per minute is about the upper limit. The rate at which passengers can adjust themselves to a change in altitude is a factor that will likely limit car speed, rather than mechanical and electrical safety considerations.

It is too early in the experience with the higher-speed elevators to form definite conclusions. In New York City the 102-story Empire State Building has part of its elevators designed to operate at 1,200 ft. per minute. The experience with these cars will give valuable data on the possibilities of going to higher speeds.

The new code also allows operating double-deck cars. The first installation of these cars has been made in the Cities Service Company's new 63-story building in New York City. The double-deck car consists of two separate cabs mounted in a single frame. It is driven by a single hoisting machine and, basically, is controlled in the same manner as a standard signal-controlled elevator. Both cabs are loaded at the same time, one from the ground floor and the upper one from the first floor. Passengers are discharged from the two cabs at the upper floors at the same time, one cab serving the odd-numbered floors and the other the even-numbered floors.

Special operating devices are provided to coordinate the movement of the two cars. The elevator will start only when the operating handles of the two cars are in the start position and all car and hoistway doors closed. When the cars stop at floors the doors will not open unless calls have been registered for these floors. If one cab has been signalled to stop, only the doors for this cab and the floor at which it stops will open. Signals are provided in each cab to keep the operators informed as to the position of the car and hoistway doors.

Dual elevators in the same hoistway are permitted by the new code and such an installation has been in operation during the last year in the new office building of the Westinghouse Electric & Manufacturing Company in East Pittsburgh. Two separate elevator cars run on the same set of guide rails and both counterweights use the same rails. Each car is operated by a separate hoisting machine, one above the other. The top hoisting machine is for the lower car and its hoisting ropes pass



This machine is for the bottom car of the dual elevator system in the Westinghouse office building

Providing vertical transportation in high buildings has been simplified by a new elevator safety code. Double-deck cars have been installed in one building and two elevators are operated in the same hoistway in another.

down on either side of the top car. Both cars operate in the same direction, one running express and serving the upper floors and the other operating local and serving the lower floors.

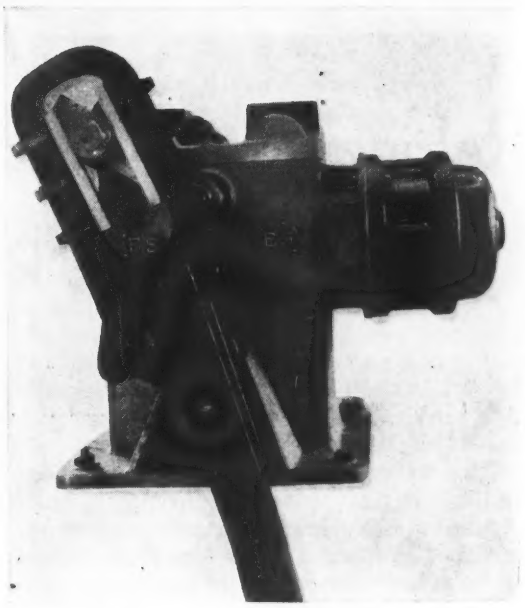
Complete tests have been made on this installation, all of which have proved successful. These elevators are probably safer than a single car in one hoistway, on account of the additional precautions taken to protect against accidents.

Where the power supply to buildings is alternating current, induction motors are generally used on the motor-generator sets for elevator variable-voltage control. Because these motors operate under light load a large part of the time, their power factor is low. In some cases static condensers have been installed to correct it. In one elevator installation synchronous motors are used to drive the generators. This no doubt will prove to be the logical solution to the power-factor problem with elevator loads.

The trend is decidedly toward the automatic elevator and eliminating the attendant as a factor in operating the car. Some elevator engineers predict that in the near future the operator will be eliminated entirely even on elevators in office and other public buildings. To this end an increasing use of automatic door operators is in evidence. These operators are now available even in small sizes, such as are required to handle the gates or biparting doors on small apartment-house or private-home elevators. The use of these operators insures that the car gate will not be left open and prevent the car being used until some one has gone to the floor and closed it.

Careful attention is being given to the design of car- and hoistway-door operators to reduce their weights and to simplify their construction. One manufacturer has brought out a new line of door operators with aluminum housings. In this design the weight and space requirements have been materially reduced.

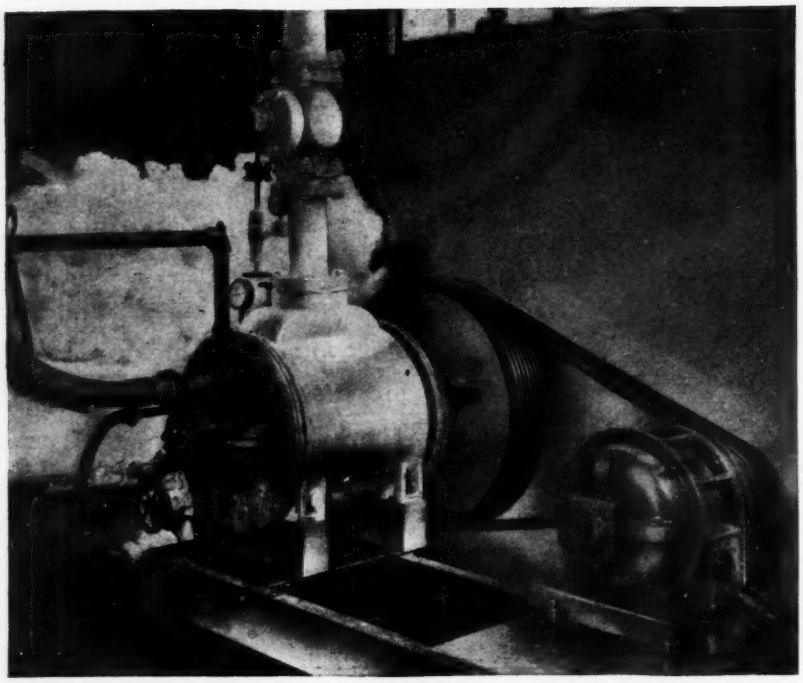
Increasing attention is being given to improving elevator service. It is beginning to be appreciated that elevators must have automatic supervision if they are to render maximum service. To do this, automatic dispatching and other supervisory systems are finding wider adoption.



A compactly designed elevator-door operator that has an aluminum housing

Those factors that affect elevator-rope life are being studied more intensely than at any previous time. These studies are being made by some of the rope manufacturers and at the Bureau of Standards. Investigations have shown that when the ropes are connected to fixed shackles in the car crosshead they are likely to be subjected to a far greater difference of loading than is generally realized. This condition is apparently one of the major factors causing short rope life.

Extensive study is being given to methods of establishing a relation between the wear and number of broken wires in a rope and its remaining useful life. It is apparent that a great deal of service data on wear and broken wires must be collected to establish a foundation of facts upon which a satisfactory wire-rope inspection method may be built.



The snow machine offers cheap refrigeration for use where ice need not be in cake form

Advances in refrigeration in 1931 include the development of a snow machine, extension of ice-flake application, combined diesel-compressor units, and improvements in dual-fluid refrigeration

Refrigeration Turns To Industrial Applications

NEW APPLICATIONS of refrigeration and new methods of ice making distinguish 1931.

While still in the experimental stage, the snow-making apparatus shown in the illustration, developed by the Vilter Manufacturing Company, holds out distinct promise of cheaper refrigeration for usages where the ice need not be in cake form. As the apparatus does away with the large, expensive ice tank and its accessories, and as the heat-transfer rate is high, reduced capital charge should make the system of distinct advantage. Essentially, the machine consists of a cooled cylinder upon whose inner surface water is sprayed and frozen, to be removed by a scraper arrangement.

Further advances in the "flake-ice" method of ice-making was registered during the year. This ice, formed on a revolving semi-submerged cylinder, is now being sold commercially for packing purposes.

More interest is being taken in the use of ice for air conditioning. Already a number of buildings are employing the system, creating a market for broken and discolored ice. There is reason to expect a further development of this system, with ice flakes or artificial snow. Existing ice plants, if the domestic market is diminished by an extension of the household machine, will find air conditioning a new outlet.

During the year marked advances have been made in the application of ice to railroad car cooling. Two railroads are experimenting with this system. It has the advantage that extensive remodeling of the car is not necessary, which is one objection that has been raised against the installation of air-conditioning systems. Another railroad is employing an iced air cooler to give an initial cooling to sleeping cars before they leave the terminal yard.

In refrigeration compressors there has been no marked improvement in design, but the installation of oil engines having the compressor cylinder mounted on the engine frame indicates that this arrangement may come into general acceptance.

The tendency to employ two compressors connected to a single motor was evident during the year, while clearance control has become standard with all compressor manufacturers.

The operation of medium-capacity ice plants by a single man who not only attends the machinery, but pulls and stores the ice, is gaining wide acceptance. The consequent reduction in labor costs contrasted to those prevailing where three or four men are employed in a plant of like capacity will help to hold down the mounting costs brought about by higher taxes and land values.

Dual-fluid systems for low temperatures has also been standardized, employing carbon dioxide for the low-temperature range and ammonia as the CO_2 condensing medium.

Quick freezing of food is still being extensively developed, but fruit freezing did not show the advances hoped for by its proponents.

The refrigeration industry feels the industrial depression along with other businesses. Since industrial applications now exceed the new installation of ice plants, the paucity of new factories built in 1931 was reflected in the reduction of industrial refrigeration plants.

Stack Discharge Problems Better Understood

Events during the year 1931, in smoke prevention activities, strongly indicate a continued and growing interest in the subject. One is particularly impressed with the enlarging sphere of activity

AS A RESULT of increased understanding and knowledge of atmospheric contamination, it is now recognized that smoke and soot, although the most apparent of air pollutants, are relatively lesser evils, and that others are cinders, fly ash, various chemical fumes, and the dust created by urban traffic and various industries. Consideration of these items has properly led to a broader view of the entire subject, which is now more accurately named the "pure air problem," with the matter of smoke abatement but a single subdivision thereunder.

Despite the fact that smoke abatement has engaged the attention of engineers and public officers for more than seventy-five years, it is significant that only now are the scientists and professional engineers coming to the full recognition that the instruments and apparatus for the accurate determination of smoke density, the control of smoke production and the elimination of atmospheric pollutants in stack gases have not in the least kept pace with the general development of other power house machinery.

The year 1931, then, should be regarded as one of realization of the technical deficiency of means wherewith to set up proper standards within which power plants, both utility and industrial, may be reasonably expected to operate. This statement should not be construed as an indictment of power engineers or the engineering profession, for all have been trying for many years to find a wholesome solution to the smoke problem, and in this they deserve full credit.

Some of the large power companies are fostering research in college laboratories, and elsewhere, with the express purpose of finding, if possible, some way to meet the public demand for the prevention or control of smoke and stack gases.

One of the most constructive undertakings in this direction is Research Professor H. F. Johnstone's work at the University of Illinois upon the elimination of sulphur compounds from furnace gases. The Utilities Research Commission, Inc., of Chicago, is cooperating materially on this project.

The results published to date have attracted wide attention in this country and abroad. In fact, one English authority has expressed regret that Mr. Johnstone's researches were not available at the time the sulphur washer installed at the Battersea plant of the London Power Company was being designed.

Another promising research of the year is in the direction of utilizing fly ash, as collected from stacks of boilers burning pulverized fuel. The numerous efforts in this category are quite well known, and to them is now added the prospect of successfully making hard-surface bricks of fly ash by a process that does not require burning, the binding of the material being effected by a chemically induced fusion.

Some colleges and institutes are also undertaking special research work. The Stevens Institute of Technology, at Hoboken, N. J., is the first to establish a research professorship in smoke abatement.

Of recent activities tending to community smoke prevention, two localities have attracted wide attention. The earlier and most prominent work is that of Hudson County, New Jersey. The other is the Division of Smoke Inspection of the Commonwealth of Massachusetts, with headquarters in Boston. The Hudson County smoke laws have been generally accepted as the most progressive yet developed, and have been used in a number of instances as the pattern from which to model laws in other localities.

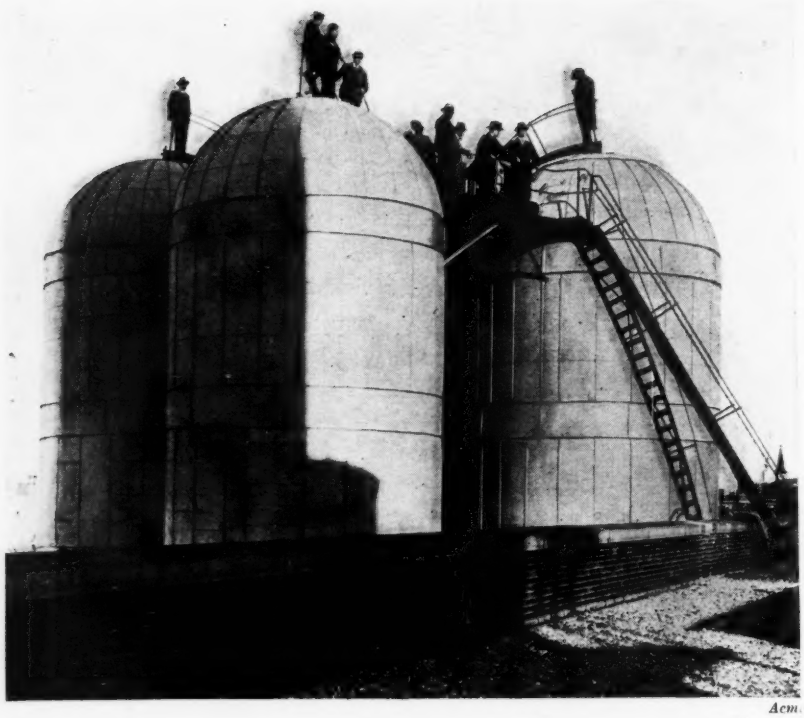
Power, in collaboration with the American Society of Mechanical Engineers, concluded the collection and tabulation of 117 different smoke laws in the United States and Canada. This tabulation shows plainly the wide variation of thought concerning the smoke abatement subject and points clearly to the necessity for a broader education and understanding of the whole subject among those responsible for the making and enforcement of anti-smoke legislation. The tabulation of smoke laws referred to appeared in the Sept. 29, 1931, number.

Under the auspices of the American Society of Mechanical Engineers, a Pure Air Committee has been organized. In addition to the A.S.M.E., membership on this committee there are also members representing the National Electric Light Association Prime Movers Committee, the Mellon Institute, and the American Society of Heating and Ventilating Engineers. The committee plans to enlarge its membership gradually so that it will, in time, be representative of all the important groups having an interest in pure air. The leadership of the A.S.M.E. is a direct result of its recognition that, in the last analysis, the elimination of atmospheric pollutants is an engineering problem and responsibility, just as the determination of what constitutes reasonably pure and healthy atmosphere is a problem for determination by the medical profession and health authorities. The two, of course, must work together.

Mechanical methods of removing solids from flue gases, although actively engaging the attention of a number of manufacturers, have shown little new development during the past year. A few new ideas are, however, at the present time under test. A large and remunerative field, nevertheless, is open to the builder of a mechanical dust-catching device of high efficiency and moderate cost.

The year has seen at least two legal actions in which complainants have alleged damage as a result of the discharge of solids from power house chimneys. One company has been estopped from discharging wash water from a cinder catcher into a local river.

Of the European countries, England and Germany are particularly engaged in the problem of atmospheric purification. France, although talking about it, seems less concerned as to its reality.



Engineers inspect the four vertical steam accumulators of the Gothersgade power station, Copenhagen, Denmark

Underfeed stokers and chain grates continue to predominate, although pulverized fuel makes headway where economics justify. Both boiler and turbine units gradually grow in capacity. Pumped-storage hydro plants as an economical means of supplying peak-load capacity continue to increase. Developments up to 600,000 kw.-hr. storage capacity are now in operation

European Units Tend Toward Larger Size

LACK of industrial activity, world-wide in extent, has had its effect on the development of power stations in Europe during the past year just as it has in the United States. The power generated by public utilities in Germany has not only not experienced the normal increase which might be expected, but has actually decreased. However, several noteworthy industrial installations have been made.

The large power-and-process-steam station which has been operating successfully for about a year at Brno, in Czechoslovakia, generates steam at 900 lb. and 800 deg. F. total temperature. The boilers are of the bent-tube type, and pulverized coal is fired from a central system. One 10,000-kw. and two 5,000-kw. turbines discharge against a back pressure of 130 lb., supplying steam through a pipe network to textile mills. The boilers operate at 900 lb. satisfactorily, with a make-up of 65 to 70 per cent, the water being passed through sand filters and zeolite softeners. Two-stage deaërators and three-stage bleeding heat the feed water. Total concentration in the boilers is held at about 800 p.p.m., with an alkalinity of 300 to 400 p.p.m. and a silica content of 50 p.p.m. maximum. Continuous blowdown is used, and amounts to 10 to 15 per cent of the feed water.

In France the outstanding power development now in progress is the new St. Denis high-pressure station in the suburb of St. Denis, just outside of Paris. This plant is designed for an ultimate capacity of 400,000 kw., with an initial installation of three 50,000-kw., single-shaft machines. Each of the three machines was built by a separate manufacturer to meet the single-shaft specifications for this plant. Each unit will have two boiler units, pulverized-coal fired and with refractory-covered water-wall furnaces. Each boiler unit will be fired by four unit mills feeding Calumet-type burners.

Power station design in England has appeared more conventional as regards steam pressures and temperatures and size of boiler and turbine-generator units than that typified by latest developments on the Continent and in the United States. The Battersea station of the London Power Company, now under construction, will have a turbine-generator of 67,500 kw., capacity, inlet steam being 570 lb. per square inch and 850 deg. F. total temperature. Power station development in Japan has likewise been conservative in the adoption of higher pressures and temperatures, as well as in the latest development in pulverized-fuel firing. The lack of industrial activity has had marked effect in reducing the number of new installations in both England and Japan.

Fuel and Fuel Firing

Coal is used almost entirely for steam generation in Europe, although some coke-oven gas is used in localities adjacent to coke plants. A large part of Germany's

steam generation utilizes the brown coals, which run about 8,000 or 9,000 B.t.u. per pound, and even go as low as 5,000 B.t.u. per pound. Chain-grate stokers are widely used with these fuels, being almost universal in the smaller standard installations. The modern chain-grate stoker, with forced draft and zoned air control through the use of compartments, has been developed to handle a fairly wide range of fuels successfully.

Modern units operating with preheated air, swinging bridges on the rear wall to maintain constant bed thickness, and without ignition or mixing arches, are handling up to 60 lb. per square foot per hour and operating at speeds up to 100 ft. per hour. Underfeed stokers are also used, several of the latest and largest installations on the Continent being equipped with them. Among these are included the Westwerke station in Berlin, the Battersea station in London, and the ten new boilers in the Gennevilliers stations, Paris.

The limited capacities at which boilers are run, even in the more modern European plants, and the comparatively low load factors at which power stations operate, have tended to limit the development of pulverized-coal firing. Difficulties due to fly ash have also had their effect. Because of these, pulverized fuel has not kept pace with the progress made in the United States. New installations are being made, however, where the economics of the particular situation justify, and the trend appears to be toward the use of unit mills. All of the Loeffler boiler installations are pulverized-coal-fired. The new Trebovice plant will have unit mills handling raw coal with up to 15 per cent moisture, and drying in the mill with preheated air. The St. Denis station will have four unit mills per boiler.

Steam-Generating Equipment

The European tendency toward medium steam pressures continues for the normal installation where standard boiler units of the straight- or bent-tube type, operating at 450 to 500 lb. maximum, are used. Such units, operating at these pressures, and at temperatures somewhat higher than are usual in the United States, constitute the majority of public utility or industrial installations.

There are several notable exceptions, however, where high-pressure boilers of the Benson, Loeffler and other special high-pressure types are working at pressures from 1,800 to 3,200 lb. The boilers of this type formerly installed had been, generally, of smaller capacities than those of lower pressures, although they are increasing in capacity in newer installations as they prove their ability to operate satisfactorily under actual conditions.

Two Benson boilers, operating at the critical pressure, 3,200 lb., have been in service for some time at the Siemens-Schuckert plant, Berlin. A Benson boiler operating at 3,200 lb. and with a capacity of 250,000 lb. per hour is operating at the Landerbrugge station in Belgium. This boiler is vertically fired with pulverized coal.

The installation at Witkowitz, consisting of three 1,850-lb. Loeffler boilers, has been increased by two more, which have a capacity of 165,000 lb. steam per hour. The Trebovice power plant, now under construction in Czechoslovakia, will also have three of these boilers of the same capacity and pressure. This is the first large utility station relying entirely on this type of boiler.

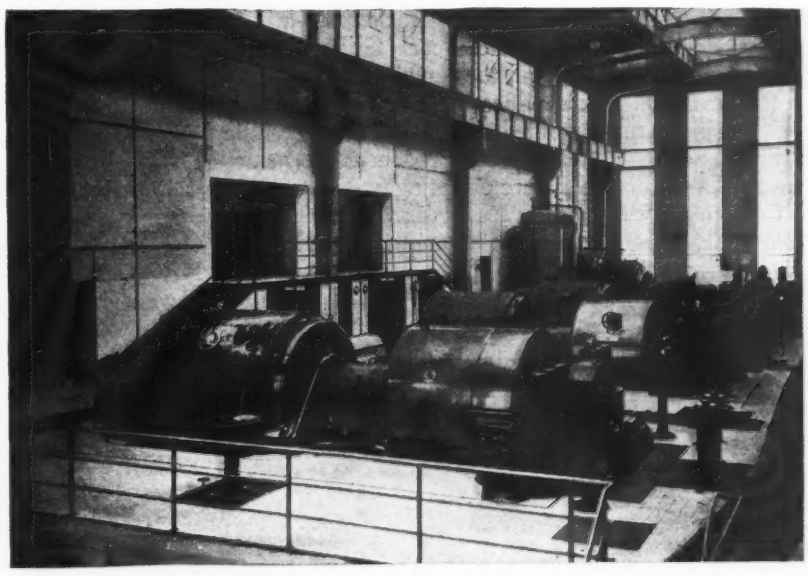
In addition, two Loeffler boilers having a normal capacity of 285,000 lb. per hour and a peak capacity of 350,000 lb. per hour are ordered for the large high-pressure power station at Moscow. These boilers will have economizers and air preheaters. The coal to be used will have a heat value of around 4,900 B.t.u. per pound. The preheated air will be about 500 deg. F., and the feed-water temperature leaving the economizers for the vaporizers about the same temperature.

While boiler capacities in European plants are smaller than those in the United States, in general, these capacities are constantly increasing. Likewise, pressures are being raised above 1,000 lb. in some of the larger new installations, in spite of the prejudice against reheating. Fusion-welded drums are not in general favor, although welding of piping is well-nigh common practice throughout the Continent in plants of all except the smallest size.

In developing boilers for pressures above 1,000 lb. European designers have in many instances made radical departures from conventional boiler design in attempting to avoid the difficulties anticipated with scaling and local overheating. In view of the high-pressure experiences with boilers of more conventional design, both in the United States and in Europe, the thought occurs that the dangers anticipated from this source have been overestimated. The experiences at the Mannheim station, to cite one example, indicate this. There serious scaling and local overheating difficulties with both the Hanomag and the Humbolt boilers, operating at 100 atm. (1,420 lb. per square inch), were cleared up by correct chemical control of the feed water. The several principles developed in these special high-pressure boilers, however, are of considerable interest.

A comparatively new development, the Brown-Boveri multi-stage injection steam generator is in many respects similar in principle to the Loeffler boiler. This boiler evaporates the feed water by vaporizing with superheated steam, but the water is injected into the steam in a series of stage evaporators. It is claimed that the

Industrial power plant at Brno, Czechoslovakia, generates steam at 950 lb. per sq.in. and 850 deg. F.; turbines discharge against a back pressure of 130 lb.



injection pump is required to handle comparatively small amounts of the circulating fluid and therefore uses little power.

Turbine Development

If a tendency could be defined for European turbine development, it would probably be toward a simplification of the multi-cylinder machine of the last few years, and an increase in the capacity of machines operating at 3,000 r.p.m. The three 50,000-kw. units now being installed at St. Denis are built for a speed of 3,000 r.p.m., and are single-shaft machines. One unit will have separate high-pressure and intermediate-pressure cylinders exhausting in parallel into two double-flow, low-pressure cylinders. Thus the unit will have four low-pressure elements working in parallel and exhausting into four condensers. The other two units are somewhat simplified, one having one single-flow and one double-flow low-pressure cylinder, thus using only three condensers, and the other having a combination intermediate- and low-pressure cylinder using the full steam flow from the high-pressure element, and a low-pressure element taking only one-third of this steam, while the remaining two-thirds is bled between the intermediate- and low-pressure elements and led into a double-flow, low-pressure cylinder. This unit also has three low-pressure elements working in parallel and exhausting into three condensers.

Turbine Auxiliaries

Several installations of the Ljungström double-rotation turbine in the larger sizes have been made. The 50,000-kw. machine is now being erected at the Vasteras station in Sweden. This turbine has also found favor as a back-pressure unit for industrial service, because of the high efficiencies developed. Another interesting development is a small axial-flow turbine on the reaction principle, which shows high efficiencies at varying loads. This turbine has been adopted as a drive for auxiliaries in power stations, an installation of this type having been made at the Hell Gate station in New York.

Three-stage extraction is the rule, the tendency being to do away with the unnecessary complication resulting from four or more extractions. Stainless steel and chromium-plated steel are both in extensive use as blading material. These materials seem to stand up well, except where the steam contains chlorides. In this case the corrosion of stainless and of chromium steel appears to be worse than with ordinary nickel steel.

The development of a compact single-base turbine which can be shipped from the factory completely erected in the smaller sizes simplifies installation. Steam reheating is generally avoided in European installations, although some few of the larger modern stations, such as the St. Denis, in Paris, are adopting it.

Condensers, almost universally, have sheet-metal shells, frequently riveted, and in some cases welded. The advantages of the welded shell are recognized, and it is probable that this method of construction will increase in the future. Two-flow condensers are still preferred, although the single-pass condenser has been successfully used on a number of large marine installations. Simplified piping arrangement may favor increased use of this design.

The water-storage pumping plant continues to find favor in Europe as an economical means of supplying peak-load capacity. Stations of this type use excess water at hydro stations in off-peak periods or in periods of excess flow to store water in large reservoirs to use over peak periods. Steam-generated current is likewise used for water pumping to storage, from which it can be run off through the hydro-turbines during peak periods. The over-all efficiency of such plants, measured from the input of the pump to the output of the generator, is between 50 and 60 per cent, and depends on the number of peak-load-hours per year so generated, and on the quantity of kilowatt-hours stored. Such plants have been considered advantageous in Germany, where almost half of the current delivered by public utilities is generated with cheap brown coal. Several such pump-accumulator stations have reservoir capacities of 500,000 to 600,000 kw.-hr., and peak-load outputs of 75,000 to 140,000 kw. One of the largest of such developments is the Herdecke storage plant in the Ruhr, with four 48,000-hp. turbines. This plant is similar in many ways to the Niederwartha plant on the Elbe River, near Dresden, although it is larger.

The Bringhausen power station, on the Eder River, near Hemforth, in Germany, is another pumped-storage hydro-plant and has what are probably the highest-head reaction turbine wheels now installed. This plant has four 40,500-hp. Francis-type wheels operating under a head of 1,000 ft. The units being horizontal in type, a 36,000-kva. generator is coupled to one side and a 100,000-g.p.m. pump to the other.

In the Vargon hydro plant, on the Gotha River, in Sweden, vertical Kaplan turbines with wheels 26 ft. 3 in. in diameter and operating on a net head of 14 ft. have been installed.

A considerable section of German engineering opinion favors steam boilers and turbines of 50 per cent or more overload capacity and fairly flat efficiency curves for peak-load purposes. The argument advanced by this group is that the economical point, as far as these peak-load installations are concerned, is of secondary importance, because the peak-load kilowatt-hours generated rarely exceeds 5 per cent of the total production.

Steam Accumulators

Steam accumulators are also used to supply peak-load capacity, the first large installation on the Continent having been made at the Charlottenburg station in Berlin. Installations have since been made in Gothenburg and Norrkoeping in Sweden, at Hattengen in Germany, Copenhagen in Denmark, and Brussels, Belgium. On the Continent twenty-one central stations in all are now operating with accumulators.

The municipal power station at Brussels has six vertical accumulator tanks of 12,000 cu.ft. each. The advantage of the vertical type of tank is the small space required, the initial cost being about 10 per cent above that for the horizontal tank.

Society and Research Activities

RESPONDING to the need of the times, engineering societies bent a considerable share of their efforts last year to the solution of economic and social problems. Much of the time of general meetings was devoted to discussion of these questions, committees were appointed and studies inaugurated.

Naturally, unemployment relief received major consideration. The American Engineering Council formulated a public works program based on the speeding up of all construction undertaken by national, state, county and municipal governments. One part of the program, the emergency plan, involves determining the status of every public project, removing causes of delay and suggesting added improvements. The other, which deals with future problems, aims to promote security, increase leisure, balance public and private economic enterprises, and integrate agriculture and industry. Both are being carried forward through state committees of the council in cooperation with governmental and social agencies.

A survey based on government statistics and the Engineering Societies Employment Service revealed that unemployment among engineers amounted to approximately 10,000, or 17 per cent of the membership of the four founder societies. To meet this situation the Professional Engineers' Unemployment Committee was organized in New York, to find work and give financial aid to those in actual need.

Other social and economic activities included the inauguration by the Engineering Foundation of research in "humanics" to eliminate the evils of the machine age; a conference sponsored by the engineering alumni of Stevens Institute of Technology and Columbia University, at which the relation between engineering and economics was studied; the promotion among the smaller industries of a consciousness of the important part they play in the business structure through the First Conference on Management Problems of the Smaller Industries; and the formulation by the American Society of Mechanical Engineers of a far-reaching program for developing the professional position of the engineer, as the result of a report completed by its Committee on the Economic Status of the Engineer.

Technical developments received full consideration at the usual number of national and sectional meetings of the various societies. Four major conferences devoted exclusively to power and related subjects were held during the year. These were the Fifth Midwest Power Engineering Conference, Chicago, in which nine societies participated; the Southwest Power Conference in Kansas City, sponsored by thirty-five engineering, utility, educational and trade organizations; the joint symposium on high-temperature engineering of the American Society for Testing Materials and American Society of Mechanical Engineers in Chicago; and the Third International Conference on Bituminous Coal at Pittsburgh, which was attended by scientists and engineers from fifteen nations.

Other events of interest in the United States included the organization of the Pure Air Committee by the American Society of Mechanical Engineers to coordinate work on smoke abatement, the consolidation of five New York chapters of the National Association of Power Engineers to form the Greater New York Association No. 1, and the adoption of a standard system of written and oral examinations for the registration of engineers by the National Council of State Boards of Engineering Examiners.

Abroad the Verein Deutscher Ingenieure, Germany's largest engineering society, celebrated its 75th anniversary with appropriate ceremonies at Cologne in June. More than 72 Americans attended the celebration, along with representatives of many other countries.

In September members of thirty scientific and engineering societies, led by the Royal Institution of Great Britain and the Institution of Electrical Engineers, gathered in London to participate in the Faraday celebrations commemorating the 100th anniversary of the discovery of electromagnetic induction. Tribute was paid to the memory of the discoverer, Michael Faraday, and a public historical exhibition of his work was held.

The first international congress of the new International Association for the Testing of Materials was held in September at Zurich, Switzerland. This new association, consisting of individuals and companies in the various countries, was organized to secure international cooperation, exchange of views and experience on all matters pertaining to testing materials. Contacts in the United States have been established through the American Society for Testing Materials, many of whose members belong to the international body.

Medalists of the Year

MICHAEL I. PUPIN, Columbia University, John Fritz Gold Medal.

EDWIN W. RICE, Jr., General Electric Company, Edison Medal.

ALBERT KINGSBURY, Kingsbury Machine Works, A.S.M.E. Gold Medal and John Scott Medal.

ERIC H. EWERTZ, consulting welding engineer, Samuel Wylie Miller Medal.

A. CRESSY MORRISON, secretary-treasurer, International Acetylene Association, Morehead Medal

RALPH MODJESKI, bridge engineer, Washington Award.

ARTHUR E. GRUNERT, Commonwealth Edison Company, Melville Award.

WILLIS H. CARRIER, Carrier Engineering Corporation, John Scott Medal.

ALBERT H. EMERY, Jr., Consulting engineer, John Scott Medal

ROBERT E. KLISE, University of Michigan, Charles T. Main Award.

LEON P. ALFORD, management expert, Henry Laurence Gantt Memorial Medal.

Research

DESPITE the business depression, research activity showed a healthy growth in 1931. Many new projects were inaugurated, facilities were increased and in some instances, notably at Rutgers University, investigations were started to furnish work for unemployed scientists and engineers.

A non-profit making research foundation was established at Pur-

due University, to assist in financing and handling projects pertaining to inventions and patents for the benefit of industrial and other organizations in the State of Indiana; construction work was started on the National Hydraulic Laboratory, which will be finished early this year; and the Engineering Foundation received an additional fund of $250,000 from its founder, Ambrose Swasey, for the furtherance of research in science and engineering.

As the result of ten years' experience in carrying on cooperative research, the American Society of Heating and Ventilating Engineers adopted a comprehensive policy of coordination for all such activities. Under the new plan, centralized control is maintained through the chairman of the main research committee with the assistance of a technical advisor. All matters of policy are determined by the committee as a whole, and an advisory subcommittee is assigned to each research problem. The society renewed its contract with the United States Bureau of Mines for carrying on investigations at the laboratory in Pittsburgh.

Added impetus was given to boiler feed-water research through the inauguration of two experimental programs by the Joint Research Committee on Boiler Feedwater Studies of the American Boiler Manufacturers Association, American Society of Mechanical Engineers, American Society for Testing Materials, American Railway Engineering Association, American Water Works Association and National Electric Light Association. These programs are being conducted under two new fellowships established by the committee. One at Ohio State University is working on the determination of the priming and foaming characteristics of boiler waters, while the other at the University of Michigan is investigating various methods of water analysis.

Throughout the year the experimental part of the A.S.M.E. Committee on Thermal Properties of Steam was continued at the Massachusetts Institute of Technology and the Bureau of Standards. Much of the time was spent in designing and constructing a new stainless-steel bomb and a steel calorimeter. With this equipment, it is expected that measurements of volume, saturation pressures and temperatures up to 2,500 lb. will be started early this year. No international steam conference was held in 1931, but close touch was maintained with foreign developments. The next conference will be held in Boston, Washington and New York on Sept. 12 to 18, 1932.

Considerable progress was reported by the A.S.M.E. Committee on the Removal of Ash as Molten Slag From Pulverized-Coal Furnaces. Studies were made using a platinum-wound laboratory furnace supplemented by a somewhat larger gas-fired furnace, of the fluxing qualities of iron ore, limestone, dolomite, fluorspar, salt-coke, steel slags and silica. Indications were that limestone and dolomite were equally effective from 2,600 deg. up, but plant tests will be held soon to confirm the laboratory experiments.

Other research activities of the A.S.M.E. included the publication of a comprehensive bibliography of the causes and prevention of corrosion and other forms of deterioration in condenser tubes, the completion of a study on dynamic loads on gear teeth, the compilation of a full description of fluid meters, the issuance of a supplement to the bibliography on the effect of temperature on the properties of metals and the inauguration of an experimental program to determine the relation between the number of broken wires and the wear of wire rope and its remaining useful life.

Several research projects were carried forward by the Bureau of Engineering of the Navy Department. One of these resulted in the development of a boiler for light cruisers, combining desirable features of the old B. & W. water-tube boiler with those of the express-type boiler, particularly with respect to weight saving. In investigating the formation of scale in naval boilers it was found that one of the main causes of this trouble was the cement wash used to protect the surfaces of feedwater tanks. Experiments are now under way to determine a satisfactory substitute coating. A special test boiler was constructed to investigate feedwater treatment and to determine the value of colloids and chemical treatments now recommended by various manufacturers.

The department completed a study of work values of fire brick for determining the relative durability as well as refractoriness. It made a special investigation of slagging in furnaces and continued its study of various steel alloys for boiler tubes with relation to their freedom from corrosion and the possibility of reducing boiler weight. Other activities included the development of a new method for recording creep of metals at elevated temperatures and the continuing of studies on the efficiency of heat-insulating materials and the durability of condenser-tube metals.

As a result of a study made by the Bureau of Standards, methods were developed for calculating the quantity of heat absorbed when one pound of frozen or partially frozen brine is heated to any higher temperature and practical tables were prepared for use in refrigeration plants. The bureau also developed a relatively simple comparison method for the determination of thermal conductivity of metals at elevated temperatures for commercial purposes. As a basis of all commercial alloys for high-temperature service, the creep characteristics of the Cr-Fe-Ni series were studied.

A radically new type of power plant is being investigated by a group of three utilities. This plant makes use of wind and employs the Flettner rotor. Preparations are being made to test one unit of 1,000 kw. capacity at the Burlington station of the Public Service Electric & Gas Company. This unit will employ a rotor about 90 ft. high and 22 ft. in diameter, mounted on a truck, the wheels of which will drive the generator.

1931 Necrology

Sir CHARLES PARSONS, inventor of the steam turbine, Feb. 11.

Lt.-Gen. EDGAR B. JADWIN, former chief of Army Engineers, Feb. 25.

CHARLES W. NAYLOR, past president of the N.A.P.E., March 8.

JOHN R. WILDE, chief engineer of power plants, Detroit Edison Company, March 29.

CHARLES S. BLAKE, chairman, Hartford Steam Boiler Inspection & Insurance Company, March 31.

Prof. ARTHUR J. WOOD, head of the mechanical engineering department, Pennsylvania State College, Apr. 18.

Dr. SAMUEL W. PARR, professor emeritus of applied chemistry, University of Illinois, May 16.

EDWARD DEAN ADAMS, pioneer in the power development of Niagara Falls, May 20.

THOMAS ALVA EDISON, world famous inventor and scientist, Oct. 18.

Dr. SAMUEL W. STRATTON, chairman of the Massachusetts Institute of Technology Corporation, Oct. 18.

LEWIS T. ROBINSON, in charge of the General Electric engineering laboratory, Nov. 11.

Dr. KENNETH G. MATHESON, president of Drexel Institute, Nov. 29.

READERS' PROBLEMS

Conducted by L. H. MORRISON

FLOW OF STEAM—*I should like to know the quantity, in pounds per hour, of steam flowing through a 3-in. standard pipe when the initial pressure is 50 lb. gage and the pressure drop is 20 lb. in 75 ft. Included in the 75 ft. are five 90-deg. elbows and one globe vale wide open.* I.M.H.

The resistance of 3-in. screwed fittings in terms of equivalent lengths of pipe are: 90 deg. elbow, 5.72 ft.; globe valve, 17 ft. The total equivalent length of pipe is then $75 + 5 \times 5.7 + 17 = 120 +$ ft. The amount of steam can be calculated from the equation

$$P_1 - P_2 = 174.2\, f\, w^2\, V\, L \div d^5$$

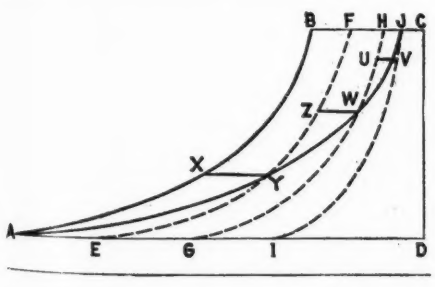
Where $P_1 - P_2$ = Pressure drop.
f = Coefficient of friction.
W = Weight per second.
V = Volume of one pound of steam.
L = Pipe length in feet.
d = diameter, inches.

A more convenient way is to make use of the chart on page 377 of Mark's Handbook. The pressure loss per 100 ft. is $\frac{20 \times 100}{120} = 17 +$ lb. From the chart mentioned the flow is found to be approximately 175 lb. per minute.

COMPRESSOR DISCHARGE TEMPERATURE—*Recently the statement was made by an instructor in an engineering school that if some of the air being compressed leaked by the piston the remainder suffered an increased volume compression ratio to bring it to the discharge pressure, and since the temperature depends upon the volume ratio, according to the expression* $\left(\frac{V_1}{V_2}\right)^{n-1} = \frac{T_2}{T_1}$, *this leaking would cause the discharge temperature to rise. Is this true?* C.V.R.

No, the statement is in error. Leaking by the piston may cause the air on the suction side of the piston to be raised in temperature, which, in turn, will cause the final temperature on discharge to be higher than normal.

Leaks, however, do not change the volume ratio of any particular portion of the air. In the illustration *A B C D* outlines a typical indicator diagram, while *A J C D* is a diagram when there is a pronounced piston leak. The air volume represented by the suction line *AD* may be pictured as being made up of volumes *AE*, *EG*, *GI* and *ID* separated by diaphragms. When compression reaches point *X*, one might picture the leaking of the suction volume *AE*, with the compression line moving horizontally from *X* to *Y*.



Compressor indicator diagram

Continued compression would bring the line from *Y* to *Z*, whereupon the leaks would shift the line from *Z* to *W*, and from *U* to *V*, and the compression would end at *J*. We would have, then, a compression of all the air to some point as *X*, the compression of the volume *ED* to *Z* and the compression of the volume *GD* from *W* to *U*. The volume ratio of *ID* would be the same as when no leaks existed, while the remainder of the air leaked away before this ratio was reached. Consequently the discharge air would not experience a rise in temperature.

CUSHIONING OF STEAM-PUMP PISTONS—*What prevents the piston of a pump from striking the cylinder head?* T.R.

The steam cylinders are provided at each end with two sets of ports. Each outer port acts as the steam admission port and terminates at the end of the cylinder so as to guide the incoming steam into the clearance space behind the piston; and each inner port acts as an exhaust port and terminates nearer the middle of the cylinder. When the steam piston passes over the exhaust port, no more exhaust steam can escape and, without cushioning valves, whatever steam is thus entrapped in the cylinder is compressed and acts like a cushion in bringing the piston to rest.

This compression may be excessive and, by means of hand-operated compression valves that connect the outer or steam ports of the cylinder with the inner or exhaust passages, the amount of cushioning can be reduced, by permitting more or less of the compressed exhaust to escape from the end of the cylinder through the steam passage into the exhaust passage.

MAXIMUM CO_2 WHEN BURNING FUEL OIL—*What is the most economical percentage of CO_2 to obtain in flue gases from combustion of fuel oil in boiler furnaces?* G.M.

For fuel oil of average analysis, theoretically perfect combustion would yield about 15.7 per cent of CO_2 in the flue gases. It must not be understood, however, that the air supply should be cut down to the extent necessary for obtaining such a high percentage of CO_2, for, as in burning other fuels, the best results are obtained when the excess air is the minimum that will completely consume the oil.

The percentage of CO_2 giving highest boiler economy in any instance must be determined for the fuel analysis, burners and other special conditions. A perfectly clear stack indicates excess air, and smoke indicates a deficiency of air. With a well-designed furnace the best results are obtained by running near to an appearance of smoke with a slight haze in the gases. Under this condition the percentage of CO_2 usually will be approximately 14 per cent, with no more than a trace of CO.

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White and Red Lead as Pipe-Jointing Compounds

THE PREVIOUS QUESTION

I SHOULD like to have from POWER's *readers data as to the relative merits of white lead and red lead as a pipe-jointing compound for brass pipe and for galvanized pipe. I have had some ideas about this matter for some time, but I must admit that they are based on what seemed to be good practice and not directly upon any authoritative information on the subject.* H.C.R.

TO STUDY any subject properly, something of the background must be set up, which in this case is ably done by L. D. Baku, Cleveland, Ohio, who writes as follows:

Up to fifteen years ago red lead contained about 85 per cent Pb_3O_4, the remainder being PbO, or litharge, as it is usually called. Litharge when mixed with linseed oil or glycerine makes a quick-setting and durable cement, and the 15 per cent that was in commercial red lead was sufficient to oxidize the linseed oil to a hard paste in a short time. For this reason red lead could not be kept in paste form, and was sold as a dry powder to be mixed as used.

About fifteen years ago the leading lead producers succeeded in making a red lead which contained from 92 per cent

to 99 per cent Pb_3O_4, the first being able to retain a pasty form for some months, the higher percentages indefinitely.

Assuming that the present-day pipe fitter has to choose between strictly pure white lead in oil and strictly pure red lead in oil, the former is less expensive, being bulkier, and the latter is a little quicker in drying. With the old-fashioned red lead or with litharge a joint made up and allowed to set for a few days can hardly be unscrewed without heating; so in putting up a joint which is to stay for all time one should use a little litharge and linseed oil paste.

All lead salts have a drying action in linseed oil, even chrome yellow and chrome green, but none makes the flint-like surface that litharge gives.

There is a great deal of so-called "plumber's white lead" which contains little or no lead at all. Out of a number of samples the best contained 36 per cent white lead; some were made out of lithopone, or leaded zinc, with barytes, and what is even worse, were ground in a mixture of linseed oil and paraffine oil. As many plumbers and pipe fitters say this is just as good and as it is sold at half the price of red lead, Mr. Baker is inclined to believe that, with good threads, lubricating oil is all that is necessary.

There is no difference between threading and coupling galvanized pipe and black pipe, as threading the pipe and tapping the fittings remove the galvanizing. If a high-class job is desired, the ends of the pipe and the interior of the fittings should be painted, either with red-lead or red-oxide paint. Both have higher inhibitive (rust-preventing) properties than white lead, and the last is also open to the objection that some lead soap is formed with the linseed oil, which is slightly soluble in cold water.

For brass pipe it is advisable to use cylinder oil. Tallow or lard oil is also good, and ordinary lubricating oil can be used, but the pipe screws in a little easier with the animal lubricant.

TURNING to the practical application of the compounds, Charles J. Mason, Brooklyn, N. Y., has very definite ideas as to the advantages of white lead. He says that as between red lead and white lead for pipe-jointing compound the difference is that any kind of metal piping that has been screwed tight with a jointing of red-lead compound, which is usually made of red lead and boiled linseed oil, is most difficult to disconnect after the compound has set. Usually the pipe will twist off before it will unscrew. With white lead used as a jointing material the case is different: It will not harden to the same extent as will red lead, and pipes so made up can be disconnected, that is, unscrewed with comparative ease and without damage to the pipe or the fitting into which it is connected. The foregoing is particularly true in cases where the piping is subjected to steam heat. For piping that may have to be disconnected at some future time he prefers a graphite compound, but desiring to secure pipe joints that were never to be disconnected he would use red lead.

[Mr. Mason apparently attributes the hardness of the joint to be red lead. If white lead is mixed with linseed oil the joint becomes equally hard.]

A SOMEWHAT different view is taken by M. M. Gooch, Atlantic Highlands, N. J., who feels that there is not much difference between red lead and white lead as regards quality. But since red lead hardens more quickly than white lead he prefers it where pressure is to be turned on soon after the joints are made up. Red lead is an oxide of lead, whereas white lead is a carbonate of lead.

White lead seems to be a bit more durable than red lead, but as already stated it must be given more time to set. Of course, he adds, one should always use quick wicking on copper and brass pipe. In fact, there is no reason why quick wicking should not be used on iron pipe. The best pipe, men are using it more and more with both white and red lead.

Why not use litharge? he asks, adding that he prefers litharge to both red lead and white lead on iron pipe where a truly durable and tight joint is wanted. Litharge hardens even more quickly than red lead.

[The editor does not subscribe to employment of wicking on brass pipe. Such joints are permitted only because the particular brass pipe used is too thin to give full threads. It is better to employ full-thickness brass pipe.]

THE ENTIRE idea of employing a compound to seal pipe joints is abhorrent to V. C. Wood, Deer River Powder Company, Copenhagen, N. Y., who declares that in twenty years of experience with water and steam pipes he has never used either. The majority of leaking joints are caused by poor threading, or by not using enough threads in making up the joint.

Mr. Wood uses powdered graphite mixed with machine oil of a consistency such that it can be applied with a paint brush. He paints the thread and the sleeve also, which makes a joint that will be tight and can be taken apart after long service without undue strain on pipe. He cites pipes to water-cooled bearings in a hydro-electric plant that are taken apart four to six times a day, during the Spring and Fall when trash plugs the strainers, and the pipes last for years. The graphite fills the rough spots in the threads and does not harden like paint will. To accomplish this he takes pains to get good threads on the pipe and not less than five threads in a joint.

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A Question for Our Readers

IS IT TRUE that vertical steam engines can be operated without cylinder lubrication when superheated steam is employed?

E.N.R.

Suitable answers from readers, if received promptly, will be paid for when published.

Sacramento Voters Veto Silver Creek Project

AT A SPECIAL ELECTION held recently in Sacramento, Calif., a proposal to float $12,600,000 in bonds to finance the construction of the Silver Creek water project was defeated by a very narrow margin. The vote stood: Yes, 13,587; No, 7,871. The bonds received a majority of 5,716 votes but failed by 717 votes to secure the required two-thirds majority.

Prior to the election the Sacramento Municipal Utility District had reached an agreement with the Pacific Gas and Electric Company whereby the power company would lease the water to be impounded at the proposed Silver Creek dam and use it for the generation of power. The Municipal District planned to spend $10,800,000 for the construction of the water project and $1,800,000 for the construction of conduit and tunnels to carry the water to the mouth of Brush Creek. There the power company planned to erect a 30,000-hp. power plant to cost about $2,500,000. Under the plan outlined, the district expected to use the revenue received from the sale of water to the power company for amortization and interest charges on the bonds. What effect the results of the election will have on the power company-Municipal District arrangement it is too early to forecast.

Texas-Chicago Gas Line Interests Change Set-Up

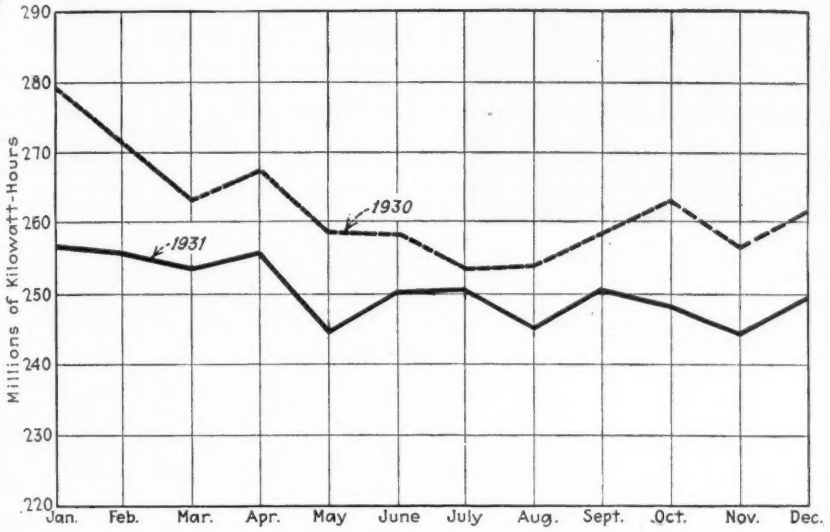
TO FACILITATE further operations necessary in the drilling for and distributing of natural gas, the utility and petroleum interests that constructed the Texas Panhandle-Chicago natural gas pipe line have formed several new companies. As an initial step, the Continental Construction Company has been changed to the Natural Gas Pipeline Company of America and its capital increased from 500,000 no par shares to 1,500,000, also no par.

The new company will direct the operations of the extensive natural gas interests involved in the operation of the Texas-Chicago line and in any future projects. This company is controlled by the Cities Service Company, Middle West Utilities, Standard Oil Company of New Jersey and Texas Corporation and will replace the Natural Gas Company of America, which will be eliminated.

The Continental Construction Company will be replaced and its functions taken over by the American Gas Pipe Line Company, the name of which will be changed shortly to Continental Construction.

NEWS of the FIELD

Public Utility Power Production for 1931 4.8 Per Cent Below Total of Last Year



Average daily production (November and December estimated)

TOTAL PRODUCTION of electric energy by public utility power plants in the United States during 1931 amounted to 91,383,000,000 kw.-hr., according to estimates based on figures of the National Electric Light Association and the Geological Survey of the Department of the Interior. Compared with the 1930 output of 95,936,000,000 kw.-hr., this shows a decrease of approximately 4.8 per cent.

As indicated by the chart of daily production, the output during the first five months of 1931 averaged about 6 per cent under that for the corresponding months of 1930. In June of last year production increased, reaching a maximum in July of 2 per cent below the 1930 period. From then on it continued to decline until it was again 6 per cent below 1930 in October, the last month covered by data available from the Geological Survey. N.E.L.A. weekly figures indicate that output for November and December was approximately 5.2 per cent below 1930 periods.

Due to deficient precipitation, the production of electricity by water power continued to decline in 1931, reaching in October the lowest point since January, 1926. In that month hydro-electric plants produced only 26 per cent of the total amount generated by both water and fuel power, the lowest percentage since 1919 when the Survey started publication of power production statistics.

As there has been an increase of about 40 per cent in the capacity of water wheels installed in public-utility power plants since 1926, and the capacity is now sufficient to produce more than four times the electricity generated by the use of water power in October, these figures indicate the effect of the drought, which has now continued for about two years.

Standard Gas Construction Budget Totals $25,015,966

STANDARD GAS & ELECTRIC COMPANY'S preliminary construction budget for 1932 will total $25,015,966, according to John J. O'Brien, president. Projects now under construction at properties in the company's system amounting to $3,508,034 will not be completed during 1931, costs for which are included in the preliminary budget figure set up for 1932. Unfinished construction during 1931 includes the Prospect diversion project of the California Oregon Power Company system which will not be placed in service until 1932.

The total preliminary budget expenditure for 1932 may be segregated as follows: electric department, $16,347,300; gas department, $3,319,809, and other departments, including general construction, $5,338,857.

Engineering and construction services for these projects will be rendered by Byllesby Engineering & Management Corporation, the wholly owned subsidiary of Standard Gas and Electric Company.

The total installed steam and electric generating capacity in the Standard Gas system is now 1,539,477 kw., serving 1,658 commuuities having a combined population of 6,000,000 located in twenty states.

N. Y. Academy of Medicine To Hold Pure Air Exhibit

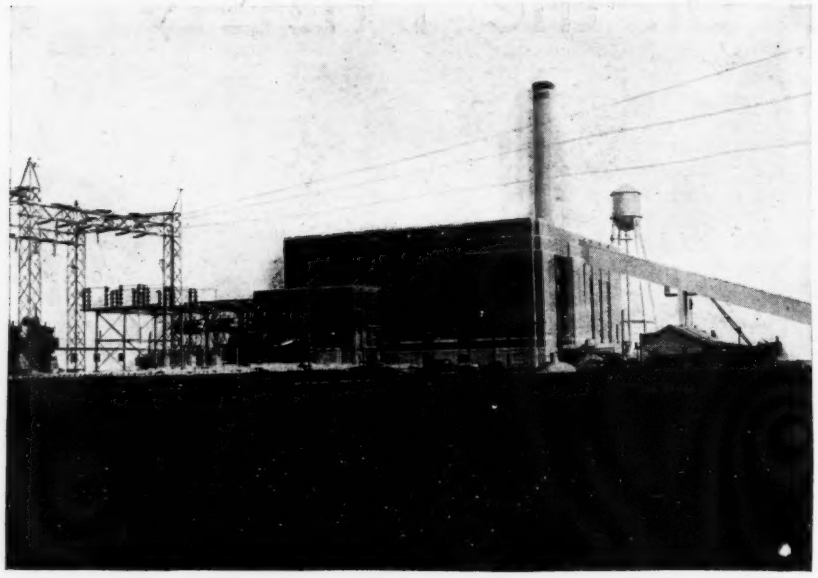
AN EXHIBIT devoted to the promotion of pure air and outdoor cleanliness will be held on Jan. 12 to 19 by the New York Academy of Medicine at 2 East 103rd St., New York City. The exhibit will be in two sections, one dealing specifically with air pollution and the other with outdoor cleanliness in relation to pure air. Both sections will display photographs and moving pictures, models, instruments, apparatus, graphs and charts related to all phases of the subject.

Exhibits in the air-pollution section will illustrate how air becomes polluted and to what extent, the harmful substances in polluted air, methods of measuring impurities, effects of air pollution and ways of preventing it. The outdoor cleanliness section will show the extent of the general problem in various cities and methods of handling it both in this country and abroad; it will contain exhibits of equipment used by various organizations and the campaigns they have carried on in appealing for public cooperation.

Add 1,950-Kw. Diesel Unit To Sterling (Colo.) Plant

PUBLIC SERVICE COMPANY of Colorado's new oil-engine electric generating equipment at the Sterling plant went officially on the line Dec. 16, when Clare N. Stannard, vice-president and general manager, operated the starter. The new diesel engine, of 1,950 kw. capacity, doubles the present steam generating facilities of the plant. With auxiliaries, it weighs 376,000 lb. and becomes Public Service Company's second oil-engine unit. The other, a small installation, is at Estes Park. The Sterling addition cost $220,000, including brick building, 27 x 104 x 38 feet.

FIRST UNIT AT SHEBOYGAN IN SERVICE



The first 30,000-kw., 1,800-r.p.m., single-cylinder, single-exhaust turbine-generator is now in service at the Sheboygan station of the Wisconsin Power & Light Company. This unit operates on steam at 650 lb. pressure and 800 deg. F. total temperature. A second unit of the same size will be installed at a later date, and the power house is designed to provide for further additions as requirements increase

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800-Kw. Two-Unit Turbine Ordered for Paper Mill

THE Thilmany Pulp & Paper Company, which recently moved its tissue mill from Appleton to Kaukauna, Wis., for the purpose of consolidating operations and securing more economical production, has purchased a non-condensing turbine-generator unit from the Westinghouse Electric & Manufacturing Company. The purpose of the double-unit turbine, rated at 500 kw. ac. and 300 kw. dc., is for heat balance. Steam will be used for process purposes and any excess power will be fed into the a.c. bus giving a perfect control of the low-pressure steam. The a.c. generator can also be used as a synchronous motor for driving the dc. generator.

Additional equipment for the new plant includes a two-panel switchboard, two 100-hp. single-motor paper machine drives with modern speed-regulating equipment and control, four wound-rotor induction motors for the heaters, eight squirrel-cage motors with line starters, and two 250-hp. synchronous motors and control.

Vancouver Contemplates 220,000-Hp. Development

POSSIBILITY of the City of Vancouver, B. C., entering the power business in competition with the British Columbia Electric Railway Company, which has up to this time supplied electric light and power to the lower mainland of British Columbia and Vancouver Island, has been resurrected after a dormant period of two years. During this time E. A. Cleveland, chief commissioner of the Greater Vancouver Water District, has conducted a survey of the Cheamakus River region, where the city holds a reserve, and his report is now before city council.

The report stresses that estimates are based on certain assumptions with regard to unknown conditions, and can not be regarded as unassailable. It indicates that a total development of 220,000 hp., costing approximately $28,000,000, may be possible, but advises as a "necessary step" a comparison with other hydro-electric sources, or possibly steam plants, to determine whether the project, either in whole or in part, falls within economic range.

COMING CONVENTIONS

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

National Marine Engineers Beneficial Association. Annual convention at the Hotel Jefferson, St. Louis, Mo., Feb. 8-12. Secretary-Treasurer, Albert L. Jones, 313 Machinists' Building, Washington, D. C.

Fuel Efficiency Record Made by Railroads in 1931

THE GREATEST EFFICIENCY on record in the use of fuel by road locomotives was obtained by the railroads in 1931, according to a year-end statement of R. H. Aishton, president of the American Railway Association. An average of 118 lb. of fuel was required during the past year to haul 1,000 tons of freight and equipment, including locomotive and tender, a distance of one mile. This average was the lowest ever attained by the railroads since the compilation of these reports began in 1918, being a reduction of 2 lb. under the best previous record established in 1930.

Record efficiency also marked the use of fuel in the passenger service, an average of 14.4 lb. having been required to move each passenger train car one mile in 1931 compared with 14.5 lb. in the preceding year.

Court Decree Prohibits Submetering in Washington

AFTER LONG LITIGATION, the submetering of electric current in Washington, D. C., finally has been prohibited by court decree. The Supreme Court of the District of Columbia on Dec. 23 upheld an order confirmed by the Public Utilities Commission which forbids the resale of electric service. Originally it was found that 42 buildings were purchasing current at wholesale rates from the Potomac Electric Power Company and were reselling it to their tenants on a measured basis.

Preliminary attempts on the part of the commission to stop submetering met with favor. The Potomac Electric Power Company then revised the terms and conditions pertaining to its service, and by special order the commission approved this revision. The order was opposed in a test case by one of the wholesale users of electricity.

In upholding the order the court declared that "to permit any device whereby electric current is not sold by the defendant to the ultimate consumer at rates which are under governmental regulation and just and reasonable but does permit electric current to be sold to a middleman at rates which may or may not apply to the ultimate consumer, will effect the net revenue of the defendant and will be against the public interest and good public policy."

Los Angeles Asks for Bids Soon on 60,000-Kw. Station

THE LOS ANGELES (Calif.) board of water and power commissioners announced Dec. 22 that bids would be called immediately for construction of a 60,000-kw. steam generating plant to be erected at Wilmington, Los Angeles harbor. Estimated cost of the plant, to

be the first unit of a proposed three-unit plant with ultimate capacity of 180,000 kw., is $7,000,000. The municipal water and power department has on hand, it was announced, approximately $1,000,000 for construction of the proposed unit. The balance of cost of the initial unit would be paid for out of earnings, according to the department's announced plans.

An agreement between the municipality and the Southern California Edison Company Ltd., whereby the city would not construct steam generating facilities to add to its present generating system, is to expire in May, 1932. The city's presenting generating capacity is entirely in hydro-electric plants and the Southern California Edison Company Ltd., supplies the bulk of the city's requirements.

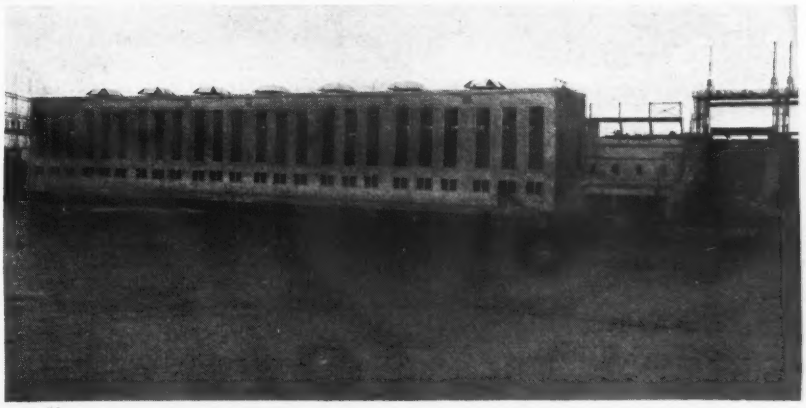
International Paper to Rebuild Hydro at Corinth

PLANS FOR A $3,000,000 hydro-electric development by the International Paper Company at Corinth, N. Y., involving the construction of a large dam creating a six-mile lake in the Hudson River, are in the preliminary stages, it was learned last week when the company obtained from Corinth officials flowage rights in the Hudson on village property. In addition, Mayor Henry R. Seigel and the Village board adopted a resolution promising all necessary cooperation to bring the scheme into being. At present paper company officials are in position to begin work within a year if it is determined that the time is propituous.

The new plant supplants both the present Curtis dam developed in 1911 and 1912 and the second dam of 1913. Under existing arrangements, electrical energy is being supplied from two separate plants using outmoded apparatus. With the proposed plant, electricity for the operation of the company's mills, current for the entire community, and a surplus for marketing would be developed.

Two plans have been proposed. One would place the dam on the site of the present one raising the river to the height of Curtis Falls. The other would erect it several hundred feet above that site. In either case the old Curtis dam would be destroyed. Between the two at present there is a drop of about 40 feet.

224,000 HP. INSTALLED AT CHATS FALLS



Eight 28,000-hp., 125-r.p.m. propellor-type turbines comprise the initial installation at the Chats Falls hydro-electric development on the Ottawa River, Ont., which went into operation recently. These units operate under a head of 53 ft. and are placed in a power house 627 ft. long. Designed for an ultimate capacity of 280,000 hp., the project features a dam extending 18,000 ft. across several islands

▼ ▼ ▼

Brawley Council Seeks Plans for Power Plant

BY A VOTE of three to two the city council of Brawley, Calif., has directed the city engineer to prepare specifications, under which it is proposed to advertise for bids for a power plant and distributing system. If the city decides to go ahead with this procedure, after final specifications have been received, it is expected a referendum election will be held to give the people an opportunity to vote on the issue.

At an election held on May 21 last, a proposed bond issue of $150,000 to build an electric distributing system was decisively defeated. The project involved the ultimate purchase of $400,000 of diesel engines for the generation of power, and this necessarily would have put the municipality in competition with the Southern Sierras Power Company, which serves Brawley. Although there has been considerable activity in this matter on the part of the city council, quite strong opposition to the project has developed among the electorate.

First Magnetic Separators Installed on Car Ferries

WHAT IS BELIEVED to be the first installation of magnetic separators in steam ships was completed recently on two new car ferries, City of Flint and City of Saginaw, built for the Pere Marquette railroad.

Both these boats are exactly alike in appearance and design; each handles a total of 33 cars and makes two trips daily across Lake Michigan. They are driven by twin electric motors of 3,600 hp. each, and the boilers are stoker fed.

To eliminate the danger of tramp iron clogging the stoker mechanism, each boat is equipped with a Dings magnetic separator.

POWER was founded in 1884 by E. P. Harris and H. M. Swetland. With it was incorporated *Steam*, which had been started by N. Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine*.

In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer*. When *The Engineer* was purchased the name of the combined paper was *Power and The Engineer*. The title was condensed to *Power* in 1911.

Ownership of *Power* passed from E. P. Harris to H. M. Swetland and James H. McGraw, then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company, in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of *Power*. Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin Van Winkle. F. R. Low was editor from 1888 until Dec. 31, 1929.

The present staff consists of Ely C. Hutchinson, editor; F. R. Low, editor emeritus; A. D. Blake, managing editor; P. W. Swain, Thomas Wilson, F. A. Annett and L. H. Morrison, associate editors; A. L. Cole, R. B. Purdy, H. R. Clark and L. E. Driscoll, assistant editors.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Prescott—City Council has instructed Arthur J. Kline, City Engr., to make plans and specifications for 5,000 gal. fuel tank and new oil burning furnace for city hall.

Calif., Long Beach—City will sono award contract for construction of a public utility building at Broadway and Pacific Blvd. Estimated cost $90,000. Dedrick & Bobbe, 901 Heartwell Bldg., are architects and engineers.

Calif., Placentia—City plans an election January 26 to vote $60,000 bonds for waterworks extensions including electrically-operated pumping station, etc.

Calif., Seal Beach—Los Angeles Gas & Electric Co., 810 South Flower St., Los Angeles, preparing plans for addition to power plant including turbo-generator of same capacity as now in use. Estimated cost $3,500,000. Work, which will be started next March or April, will be handled by owners construction department.

Calif., San Francisco—City awarded contract for six 1,667 kva. transformers to Maloney Electric Co., Rialto Bldg., San Francisco. $22,620; also one 200 r.p.m. and nine 1,000 r.p.m. synchronous motors to Electric Machinery Mfg. Co., Call Bldg. $44,630 in connection with Corral Hollow Pipe line and Hetch Hetchy water projects.

Colo., Grand Junction—Public Service Co., c/o C. N. Stannard, 15th and Champa Sts., Denver, approved $200,000 budget for construction of a hydro-electric development on Orchard Mesa, Colorado River, near here.

Colo., Pueblo—Southern Colorado Power Co., c/o W. N. Clark, Gen. Mgr., 401 Main St., plans to expend $158,000 on power plant improvements and transmission lines in Pueblo and Arkansas valley, also approved $20,000 for improving Skaguary dam at Victor.

Ind., Michigan City—Board of Waterworks, issued $30,000 bonds for construction of a new waterworks system including reserve pump, etc. Estimated cost $30,000.

Ia., West Bend—City awarded contract for improvements to power plant including 210 hp. Diesel engine and changing plant from direct current to alternating current to Fairbanks, Morse & Co., 9th and Harney Sts., Omaha, Neb. $41,260.

Minn., Minneapolis—U. S. Engineers' Office, War Dept., St. Paul, will soon award contract for construction of a power house at Twin City Locks, here.

N. Y., Canastota—Canastota Refrigerating Co., Canastota, c/o Frank Hill & Associates, North Rose, acquired yeast and vinegar plant of General Foods Corp. here and will remodel for cold storage and refrigeration plant.

N. L., Claverack—Albany Southern R.R. Co. and Eastern New York Utilities Corp., c/o Mohawk-Hudson Power Co., Rensselaer, have been granted permit for extensions to electric distribution system here.

N. Y., Corinth—International Paper & Power Co., 220 East 42nd St., New York, plans construction of a hydro-electric development 30,000 hp. capacity in vicinity of Corinth. Estimated cost approximately $3,000,000. Acquisition of flowage and other rights in progress. Maturity indefinite. No immediate development contemplated.

N. Y., Woodhull—New York Central Electric Corp., East St., Rochester, has been granted permit by Public Service Commission for extensions to gas plant distribution system.

O., Cincinnati—Cincinnati Union Terminal Co., Temple Bar Bldg., will receive bids until January 12 for construction of a mail handling building. Estimated cost $700,000. H. M. Waite, Temple Bar Bldg., is engineer.

Ore., Medford—California-Oregon Power Co., Medford, subsidiary of Standard Gas & Electric Co., 111 Broadway, New York, plans construction of a power plant in vicinity of Medford. Estimated cost $1,000,000.

Pa., Cresson — Cresson State Sanitarium, awarded general contract for improvements to boiler plant, also construction of underground gas and electric lines to Berkebile Bros., Swank Bldg., Johnstown. Estimated total cost $50,000.

Tex., Borger—Phillips Petroleum Co., Bartlesville, Okla., plans pumping and power machinery for oil pipe line here. Estimated cost to exceed $40,000.

Tex., Burkburneff—City plans construction of a municipal light plant. Estimated cost $45,000.

Utah, Ogden—State Building Commission is preparing preliminary plans for construction of a new heating plant at Industrial School here. $15,000. R. K. Brown, c/o State Building Commission, is engineer.

Ont., Windsor—Producers Cold Storage Ltd., 1330 Mercer St., awarded contract for converting cold and dry storage warehouse into cold strage plant, to Gosselin Construction C. Ltd., Windsr. Estimated cost $50,000. Contract for refrigeration awarded to Canadian Carbondale Co., Toronto.

Argentina, Buenos Aires—Argentine Government has authorized construction of a steel bridge, 568 ft. long to replace present timber bridge. Contract will be awarded in three sections: first to include foundation work and approaches, second for steel superstructure with mechanical and electrical equipment for bascule span in center and third for equipment for acoustic and light signals for street and river traffic. Total cost $1,300,000.

Equipment Wanted

Engine Pumps, Etc.—Cairo, Egypt.—Department of Interior, will receive bids until February 18 for supply and installation of a 400 kva. Diesel engine electric power station, also one deep well pump, three medium pressure centrifugal pumps, two low pressure pumps and one priming pump with electric motors, piping and all accessories.

Pumps—Chicag, Ill.—Sanitary District of Chicago, 910 South Michigna Ave., will receive bids until January 21 for vacuum and sludge pumps, filter, etc., for proposed sewage treatment works. Division D.D.

Pumps—Bemidji, Minn.—City will receive bids until January 18 for pumps, etc., in connection with underground water supply system.

Switchgears—Melbourne, Australia—Corporation of Melbourne, will receive bids until January 20 for ring main metal clad 6,600 v. switchgear and until February 3 for totally enclosed metal clad 6600 wet switchgear.

Transformers—Wellington, N. Z.—Department of Public Works, will receive bids until February 23 for four 1,000 kva. single ph. transformers.

Industrial Projects

Ark., Brinkley—St. Louis Cooperage Co., 101 Arsenal St., St. Louis, Mo., awarded contract for 50 x 130 and 60 x 70 ft. additions to plant including boiler plant, etc., here, to Clymonts & Heinicke, Wainwright Bldg., St. Louis.

Ia., Cedar Rapids—T. M. Sinclair Co., awarded contract for alterations to factory at Third St. and Sixteenth Ave., to Max Mildenstein, Merchants National Bank Bldg. Estimated cost $62,000.

La., Harvey—Continental Can Co., 1 Pershing Sq., New York, N. Y., plans construction of a can manufacturing plant here to supply Penick & Ford plant here. Estimated cost to exceed $100,000. Favrot & Livandais, Hibernia Bldg., New Orleans, are architects.

Mich., Grand Rapids — Flottorp Propeller Corp., manufacturers of airplane propellers, preparing plans for a first unit of factory, 55 x 67 ft. Estimated cost $30,000.

Mich., Howell—R. E. Barron Implement Co., manufacturers of farm implements, plans reconstruction of plant destroyed by fire. Loss $40,000.

N. Y., New York—John Lucas & Co., 521 Washington St., plans reconstruction of paint manufacturing plant destroyed by fire or reequipment of building to be acquired. Estimated cost to exceed $40,000.

Pa., Williamsport—Williamsport Die & Machine Co., plans to rebuild part of plant destroyed by fire. Loss $40,000.

Va., Martinsville—Collins Flashlight Corp., C. B. Collins, Pres., has work under way on construction of first unit of plant for the manufacture of patented no-battery flashlight, 1 story. Initial expenditure $75,000. Work being done by owner's forces under the supervision of H. H. Dudley.

Alta., Calgary — Federated Oil & Fefineries Ltd., c/o W. A. Beckett, recently incroporated for $1,500,000 plans construction of an oil refinery, 1,500 to 2,000 bbl. capacity here.

Ont., Chatham—R. D. Walsh Co. Ltd., plans construction of woodworking plant destroyed by fire. Plans include installation of boilers, engines and other machinery. Estimated cost $50,000.

Que., St. Lambert—L. E. Waterman Fountain Pen Co., Ltd., St. Lambert and 191 Broadway, New York, N. Y., plans addition to plant here. Estimated cost to exceed $40,000.

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how you can economically increase your plant output.

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